

fire like common Salt, nor flash like Saltpetre; but it would melt and swell like alum and borax, as well as ferment with acids; whence it appears to be much of the same nature as pot-ashes.

**NITRE** of the moderns, commonly called **SALTPETRE**, is a white crystalline substance, of an acrid bitterish taste, and seemingly a little cold. Its crystals are in the shape of prisms, with six sides, which are slender, long, equally thick, and terminate at each end, like a pyramid with a point. It dissolves readily in water, melts over the fire, and will not flash, unless mixed with sulphur or charcoal; and then it will with great violence. Saltpetre is often seen on old walls that are not washed by the rain, from whence it is taken off with brushes. Artificial Saltpetre is made with earth saturated with common or pigeons dung, whose salts will, in time, be converted into Saltpetre. As Saltpetre cannot be obtained, except from earth impregnated with urinous, animal, or vegetable Salt, some are in doubt whether it is a mineral or animal production; but it is generally reckoned among those that are mineral, because it may be extracted immediately from the earth, and not from any excrements themselves, unless they be mixed with earth.

The spirit of nitre will dissolve silver, whence it is called aqua fortis; and it will communicate the same power to spirit of vitriol and spirit of sulphur. However, aqua fortis will not dissolve gold; for that is only to be done with aqua regia.

**NITRE** is used in medicine to cool the blood, and to restrain the heat of a fever, to allay thirst, and to hinder putrefaction; for which reason it is commended in malignant cases. It is given from three grains to a scruple, three or four times a day. A drachm given every morning, dissolved in a draught of ale, has been found to cure the dropsy. When Nitre is put into a crucible, and placed over the fire, it will melt like water; and then, if powdered charcoal be thrown into it, it will deflagrate with a noise, which being over more powder must be thrown in, and this must be repeated till the Nitre will flame no longer. By this method, the Nitre will turn into an alkalious salt, which has the same virtue as salt of tartar. Every one knows, that Nitre mixed with due proportions of sulphur and charcoal will make gun-powder.

**VITRIOL** is either native or factitious, and, with regard to the colour, is distinguished into white, blue and green. White Vitriol is brought from Germany in large lumps, which look almost like loaf sugar, and has a sweetish astringent taste. It is found in mines at Gloslaer in Saxony, where it springs forth from the sides, under the appearance of a woolly substance, which being dissolved in water, must be boiled to a due thickness; and at last, it will turn into a white mass like sugar. Sometimes there are found in the same mines pieces of Vitriol, which are already crystalized and appear transparent.

Blue **VITRIOL** is dry to the touch, and is formed into blue crystals, like sapphires, of a rhomboidal form, but flat, and with ten sides. It is prepared in various places, but more particularly in Cyprus and Hungary; whence it is commonly called Hungarian and Cyprian Vitriol. It obtains its fine colour from copper, and has an austere taste, with great sharpness.

Green **VITRIOL** is of an herbaceous colour, and has various names, according to the different places from whence it is got. It abounds with iron from whence it has its colour, and is either in large crystals of a rhomboidal form, or in bits composed of crystalline grains united together, which feel a little oily to the touch; it has a sharp styptic taste.

**VITRIOL** is nothing else, but an acid-vitriolic salt, which by corroding zinc, copper, or iron, co-

gulates with them, and so concretes into a transparent body, which takes its colour from the metal. Blue Vitriol is now got in Hungary from water in the copper mines, near Smolnik and Newsol, by evaporation; and green Vitriol is obtained in Germany after the same manner. But in England, at Deptford, near London, green Vitriol is obtained from a stone, called Pyrites, which is heavy and brown on the outside; and, when broken, there are rays that appear to run from the center to the circumference; and consist of particles that shine like brass, and yet are without any taste. These stones, after they have been exposed to the air for some time, undergo a sort of fermentation, and then crack into clefts, out of which a kind of white down of a saltish nature springs forth, which has an acid styptic taste; at length the whole substance dissolves, and turns into a fine saltish powder, of a vitriolic taste and sulphureous smell. If these stones are calcined in the fire, a copious smoke will exhale from them, with a sulphureous smell, and a red calx will remain behind, containing a little iron and copper.

White **VITRIOL** is extremely good for making an eye-water, which is, perhaps, the best hitherto known for abating inflammations of the eyes, and to repel fluxions thereon. It is made by dissolving a scruple of vitriol in hot rose water, and then passing it through a linen cloth: a few drops of this is to be put into the eyes. When blue vitriol is calcined, it is very proper for stopping hæmorrhages, by cauterizing the vessels, and condensing the blood therein. Spirit of Vitriol, like other acid spirits, restrains the heat of the humours, stops hæmorrhages, and promotes urine.

**ALUM** is either native or factitious; but the former sort is now little or not at all known. The factitious is distinguished by the name of the country it comes from, it being of several kinds; for there is scarce a country in which it is not made. One sort is called Rooh, or Rock Alum, because it is sometimes got out of a rock, where it is often met with in very large pieces.

In Yorkshire and Lancashire they get their Alum out of a bluish stone, like slate, that is full of sulphur. It is a sort of Pyrites, which will kindle in the fire, and being exposed to the open air will break of itself. The fragments of these stones are laid in heaps, where they are burnt in the open air; and when the sulphur is quite exhausted, the fire will go out of itself, after which they steep the calcined stones for twenty-four hours in water, when it is drawn off into leaden cauldrons with the lye made with the ashes of a sea-weed. After the liquor begins to boil, they pour urine therein, which causes the sulphur, vitriol, and earthy matter to sink to the bottom. This done they take the liquor and pour it into vessels made with deal boards, where, in time, the Alum concretes to the sides, in white transparent crystals, which, after washing, are melted in iron cauldrons; after this it is poured into a tub, and forms a mass of the same size. However, in different countries, they have different methods of making Alum, which would be tedious, as well as useless, to relate.

Alum is of a very binding nature, and has always been looked upon as a great styptic. That of the ancients had a smell like aqua-fortis, but the factitious has none at all; and, when placed over the fire in an iron pan, it bubbles up and melts like water. When Alum is set to crystalize, it concretes into a figure with eight sides, which looks like a triangular pyramid, with the angles cut off; insomuch that it is composed of four hexagon surfaces, and four that are triangular. From a chemical analysis it appears, that Alum consists of an acid vitriolic salt, and an astringent earth or bole intimately united. Alum is recommended for swellings of the gums, and against the fluxions upon the tonsils. When burnt, it



it will take down proud flesh in wounds and ulcers; it is of no use internally, only it is sometimes given with a large portion of nutmeg for the cure of the ague.

**SAL-AMMONIAC**, of the ancients, was a sort of fossil Salt or Sal-gem, though Dioscorides would have it to be a kind of common Salt, which is dense, transparent, white, easily cloven, and dug out of the earth; all which have the properties of Sal-Gem; for it will readily cleave into plates.

Factitious **SAL-AMMONIAC** is of two sorts, one of which is brought from the East Indies in conical pieces like sugar loaves, of an ash colour; but this is very scarce. The other and common sort is brought from Egypt and Syria in flat cakes, convex on the upper part with a sort of a navel, and a little hollow on the other; they are about a palm in breadth, and three or four inches thick, of an ash colour without, and whitish within.

**SAL-AMMONIAC** is a very useful medicine, for it dissolves thick clammy humours, and carries them off by sweat and urine. Some commend it in agues, given to the quantity of half a drachm, with a scruple of crabs eyes before the fit. The Volatile Salt and spirit of Sal-Ammoniac are good in a lethargy, apoplexy, fainting, giddiness of the head, and hysteric fits, being held to the nose. Internally, the spirit promotes a diaphoresis, sweat and urine; it blunts acid humours in the body, promotes the circulation of the blood, refreshes the spirits, excites the oscillations of the nerves, and opens obstructions. Whence it is good in the apoplexy, epilepsy, lethargy, sleepy diseases, and in hysteric fits. It may be given from six drops to a drachm in any proper liquor.

**BORAX** is of two sorts, the one native, and the other refined. Native Borax is brought to us in bits of the size of large hazel nuts, and of a dark green colour, covered with a sort of earthy fat matter. It is found in various places, and is brought from the empire of the great mogul, and from Persia, where it is found in mines of metal, especially those of copper, from whence proceeds a saltish, muddy, greenish water, which is carefully caught, and being evaporated into a proper thickness, is afterwards poured into pits lined with a paste, made with the mud of these springs, and the fat of animals, which are also covered with the same paste. After some months they are opened, and find the water concreted into stones. When Borax is purified, it appears clean, white and transparent, somewhat like the crystals of Alum, with a slight saltish taste, and a lixivious sharpness. It is of the same substance with the native, and was formerly brought from Venice. It is imported to us from the East Indies, and principally from Bengal. When Borax is placed over the fire, it swells like Alum, and at length melts into a hard transparent mass, resembling glass, which, however, will dissolve in water. After examination, it appears that Borax is a sort of a fixed Salt not unlike that of Tartar; but differs from it in joining with acid Salts, without any effervescence. Borax is used by goldsmiths for soldering gold, and to render the melting of metals more easy; likewise, it is employed by some dyers to give a gloss to their silks.

## C H A P. XIX.

### OF SULPHURS, BITUMENS and COALS.

**COMMON SULPHUR**, or **BRIMSTONE**, is either native or factitious, or rather depurated. Native Sulphur, commonly called Sulphur Vivum, is either transparent or opaque; the transparent appears like a gem of a gold colour, though some is

met with that is yellowish or greenish. It is found in the gold mines of Peru; particularly in Quito, on the island of Milo, in the Archipelago, and in the canton of Bern, in Switzerland. The opaque is usually met with in hard solid masses of a greenish shining colour, or under the form of an ash coloured clayey glebe, inclining to yellow. It is in the greatest plenty at the feet of the mountains that throw out fire and smoke, such as Vesuvius, Etna, Hecla, and the like; as also in some parts of Europe and America, where there are sulphureous earths or fountains.

Factitious **SULPHUR** is prepared several ways; for in some places it is boiled in water, as at Buda in Lower-Hungary. At Aix la Chapelle, in the hot baths, Sulphur is raised in vapours from the water, and sticks to the cover of the spring in hardish lumps, that have the appearance of flower of Sulphur, and a great quantity of this is gathered every year. Sometimes it is extracted from a whitish clayey earth; and is as often obtained from the stone called the Pyrites, particularly in the diocese of Liege, where they are found like lead ore.

**ORPIMENT** is an arsenical juice, compacted into gleans, consisting of thin scales or leaves, almost like Icing-glass, which may be easily separated from each other. There are three kinds, one of which shines like gold, another is reddish mixed with a citrine colour; the third is greenish and mixed with earth; but the first is best. They are found in mines of gold, silver, and copper.

**ORPIMENT** has a sharpish taste, will dissolve in oil, readily take fire, and emit a copious fume, between the smell of sulphur and garlick. By the heat of the fire it will dispense in plentiful fumes, which if collected, concrete in yellowish flowers, like sulphur; and at the bottom of the vessel there will remain a blood-coloured melted mass, which, when cold, becomes thick and solid, like cinnabar. This, by some, is called red Orpiment, or Realgar. If this mass be kept longer over the fire, in a sublimating vessel, it will rise to the upper part, and there concrete into a transparent, red, elegant substance, like a ruby; but at the bottom there will remain a little metallick earth.

Hence it is plain, that Orpiment consists of the same principles as common Sulphur, only it is mixed with some mercurial particles. Some take it to be of a very poisonous nature; but Hoffman, after many experiments, by giving it to dogs, has found that it is intirely innocent. It is made use of by some barbers, mixed with lime, to take off the hair where it is superfluous; but if it lies on long, it will corrode the skin, which doubtless is owing to the lime.

**REALGAR**, called **ZARNICK** by some, is, by others, named Red Orpiment. It is of two kinds; that is, native and factitious. The native, which is got out of mines, is of the colour of cinnabar, and smells like a mixture of sulphur and garlick when it is burnt. The factitious is made with Orpiment in sublimating vessels; for the yellow part will rise towards the top, and the mass that remains at the bottom is the Realgar. However, we are not to confound this with the red factitious Arsenick hereafter described.

Realgar is brought into Europe from China, in several shapes, which they call Pagods, these seem to be made by melting, not carving. Some ancient physicians have given this inwardly; the natives of the East Indies make cups herewith, and the water poured therein, after some time, is used as an excellent remedy against several diseases. Some think that it would not have the like effect on European bodies; for they suppose the nature of man in the East Indies and ours to be greatly different; but this is a mistake. However, it is uncertain whether

Realgar



Realgar be as innocent as Orpiment, or not; but that it is not poison is certain, for Hoffman gave two scruples of it to a dog, without the least bad consequence, and he was as well afterwards, as if he had taken nothing; but this is not the case with the flowers of Orpiment, for a scruple of these being given, it excited enormous vomiting; however, it did not kill, but if the flowers are obtained another way, that is, by mixing four ounces of Orpiment with three ounces of oil of Vitriol, they will yield an ounce of the flowers adhering to the neck of the retort, which are entirely innocent; for they are almost tasteless and promote sweat more powerfully, perhaps, than any other medicine.

ARSENICK, properly so called, is in Bohemia and Saxony extracted from a mineral called cobalt. If this be mixed with calcined flints and pot-ashes, the mixture, in a very strong fire, will turn into a glass of a bluish colour, that when reduced to powder is called smalt. In the preparation of this glass a copious smoke is exhaled, or rather flowers, which sticking to the sides of the furnace, and collected together, appear in the form of a white powder, which put into a crucible, and melted in an exceeding strong fire, turns into a white, heavy, hard, glassy mass; and this is named white Arsenick, which is a most dangerous poison. But when to ten parts of the former powder, one of sulphur is added, and melted, as before, then yellow Arsenick will be produced. Again, if two parts of the sulphur are added to ten of the powder and melted, as before, it will turn to a reddish mass, which goes by the name of red Arsenick.

COBALT itself is a fossile body, which is heavy, hard, and almost black, not very unlike antimony; it has a sulphureous, nauseous smell, when kindled in the fire, and is commonly mixed with a portion of brass, and sometimes of a little silver. Cobalt is found in some parts of England, and particularly in Mendip hills in Somersetshire; but some think it is not so good as that of Saxony.

NAPHTHA, or PETROLEUM, is a mineral oil of a bituminous nature, which is inflammable, and has a fragrant smell. It is of several colours, as white, yellow, red, and blackish. There is scarce any country where this bitumen is not to be found; but in the island of Sumatra there is an excellent sort, which by the inhabitants is called *miniac tanna*, which signifies oil of earth; and this is in high esteem in the East Indies. The Italians are lavish in their praises of the Petroleum found in Modena, and obtained from certain springs and wells. The earth of this dutchy abounds therewith; but that is most remarkable which is met with in the place called Il Fumento, where there is a well near forty yards deep, whose water is mixed with this oil. Twelve miles from Modena there is a noted rock, where there is a spring, on whose water a yellowish oil is seen swimming; and this will produce about twelve pounds of this oil in a week.

Petroleum readily flames, for which reason, in many places, it is used for lamp oil. It consists of fine volatile parts, upon which account, if a candle be held over the wells or fountains that yield this oil, the vapours will readily take fire. It is difficult to unite spirit of wine with Petroleum, it being of such a fat consistence. That Petroleum is generally counted best which is fresh, white, transparent, and has a subtle bituminous smell; the next in esteem is the yellow, then the red, but the black is worst of all. A few drops of this oil is given to children to kill worms; and it is used outwardly in the palsy, and for cold pains of the nervous parts.

Mineral PITCH is a kind of reddish or blackish bitumen, having a fragrant bituminous smell. It is of a middle consistence between petroleum and bitumen, and is not unlike tar. It grows more fluid

in heat, and thicker with cold; and it emits a flame when kindled. It is by some authors called Pissasphaltum, and springs out of the earth in several places between the chinks of stones. That at Castro near Rome rises through the clefts of stones, chiefly in the summer time, of the consistence of honey, and is of a black colour and a most subtle smell. In Auvergne in France there is a plentiful spring of this bitumen, which has the appearance of tar, it being black; but if it be kept a considerable time, it will grow harder, but not so hard as pitch. That most common in England is Barbadoes tar, which is a liquid bitumen, and is used externally, for all pains proceeding from a cold cause; as well as numbness, cramps, and palsies. It is given, inwardly, in pretty large doses, for the dry belly-ach.

Jews PITCH is a sort of bitumen, which is solid, brittle, heavy, of a reddish black, shining, and inflammable, with a strong bituminous smell, especially when it is melted over the fire. It is found in several places, and particularly in Judea, from whence it has its name. It is found swimming on the top of the Dead-Sea, and is, at first, soft, thick, and may be readily pulled in pieces; but, by length of time, it becomes harder than common pitch; it is known in the shops by the name of Asphaltum. The true sort is seldom brought to us; for what we have is entirely black; only when it is broken, it has a saffron colour cast.

AMBERGREASE is of an ash colour, or grey, and is a fat solid substance, like suet, but light. It is variegated like marble, and is sometimes speckled with white; it springs from the bowels of the earth, is condensed in the sea, and is found floating on the water, though sometimes it has been met with on the sea shore, where it has been thrown by the waves. It is sometimes black as well as grey; but the grey is accounted best. There is little room to doubt that this is a sort of bitumen, which proceeds from the earth near the bottom of the sea; for it sometimes contains stones, shells, the bones of animals, and the bills and claws of birds, as well as honey-combs, from which the honey has not been all lost. Hence it appears, that this bitumen must have been first in a liquid state; it has been sometimes found in lumps of above two hundred pounds weight. A great deal of this is got in the Indian ocean, about the Molucca islands; though it has also been found near Africa, and sometimes near the northern parts of England, Scotland, and Norway.

Ambergrease will readily melt in the fire into a sort of gold coloured rosin, which will kindle and burn when held to a candle. It will not dissolve entirely in spirit of wine, but leaves a black pitchy matter behind it. The solution, after some time, will deposit a white cloudy sediment, which will coagulate by little and little, and grow thick, especially by the evaporation of the finer parts of the spirits of wine; this being dried becomes a shining sort of earth, not much unlike sperma-ceti. It consists of oily greyish particles, which are very fine and volatile, with others that are thicker, saline, and bituminous. Ambergrease is of great use among perfumers, and is recommended by physicians for raising languishing spirits, and increasing their motion; whence it is given for disorders of the brain and heart, as well as in fainting fits. The dose in substance is a pill of the size of a small pea, or from one grain to eight in a poached egg or wine.

AMBER is a hard bituminous substance, brittle, somewhat transparent, and of a yellow or citrine colour, though sometimes it is whitish and sometimes brown. The taste is somewhat acrid and bituminous, with a little astringency; the smell, when warm, is fragrant and bituminous; and when rubbed it will attract straws and bits of sticks by its electrical



electrical virtue. It is found in large quantities in Prussia, which is the country where it is chiefly got, particularly in the Baltick sea, near the shore of Sudavia, where it is found swimming upon the water, and is taken in nets. However, this bitumen is not a production of the sea; for its water only serves to wash it off from the bowels of the earth, and remove it to places near the shore. The veins of this bitumen have been found, by the order of the king of Prussia. In digging for them they first met with sand, which being taken away, a stratum of clay appeared, and still deeper there was another like old wood, under which there was the mineral of vitriol, which being exposed to the open air, it was covered with an efflorescence of green vitriol. Still deeper there was a sandy mineral, out of which, with proper instruments, they got Amber in various places. By this means, in the March near Kustrin, as also in the Tract of Stolpen and Dantzick, it was met with among sand, and found collected in heaps; whence it appears they were greatly mistaken, who took it for the rosin of trees that dropt from them into the sea. It seems to proceed from the bituminous fossile wood, just mentioned, by the assistance of the subterranean heat; which, at first, is probably like Petroleum, and after passing through the mineral of vitriol, by the mixing therewith, becomes coagulated into a hard body. There is no doubt that it has been liquid, because it is often found in a round form, containing several sorts of insects therein; besides, the oil which is obtained from Amber, is, for virtue and smell, like Petroleum. Charlton, who was a very great naturalist, has sometimes found real Petroleum included in pieces of Amber, which is a farther reason to prove what is asserted. The greatest plenty of this bitumen is found near the shore of Sudavia, after a violent north wind, attended with a tempest. Sometimes Amber is so transparent, as to serve to make burning glasses, one of which is kept in the cabinet of the Landgrave of Hesse-Cassel. Amber, properly prepared, becomes a medicine for opening the obstructions of the bowels, and promoting all sorts of excretions; and consequently is a very useful remedy in chronical diseases. It is likewise said to be very efficacious in curing cold disorders of the brain, and particularly in pains of the head, sleepy and convulsive diseases, as well as in hysteric and hypochondriac fits. The dose is from a scruple to a drachm in a poached egg, or any other proper vehicle. The volatile salt of Amber is diuretick, and accounted a specific in hysteric and convulsive diseases. The dose is from ten grains to thirty. The oil is commended in nervous disorders, particularly in the gout, palsy, and catarrhs, by anointing the parts therewith. It is given inwardly from two to twenty drops.

**JET**, called by some Black Amber, is a bituminous substance, dry, hard, black, smooth and shining, and being set on fire turns almost like pitch, emitting a thick black smoke, with a bituminous smell. It differs very little from pit-coal, especially the finer sort, which we call Kannel coal, if it be not the very same. It differs from a bitumen in not melting as that will do, and when distilled it yields a sharpish acid phlegm, and then a black oil; but last of all a substance like butter, or thick oil. It leaves behind it a very black caput mortuum.

**PIT-COAL** is universally known in these parts, and when distilled in a retort, first yields a phlegm, then a sulphureous spirit that is a little acrid, which is afterwards succeeded by a subtle oil, and then one that is thick, which sinks to the bottom. With the greatest degree of fire there is produced a sort of an acid salt, like that of Amber, leaving behind it a light black earth. When the spirit is thrown on quick lime, it becomes volatile, and strikes the nose

with a strong smell; spirit of nitre being added to this, a white smoke will arise, which yields a very pleasant sight. The foetid oil being mixed with salt of tartar, has the smell of a volatile salt, and when this mixture is distilled, it yields an alkaline, volatile, oleous spirit, which will turn syrup of violets green; but if it be mixed with an acid, it will immediately ferment, and become of a bright red colour. The thick oil of coals has a sulphureous smell, and being put into a silver spoon, with a gentle heat, will turn it blackish, which is a certain sign there is a true mineral sulphur contained therein, for common sulphur, dissolved in oil of turpentine, will do the same. Hence it is plain, that coals contain nothing that is unwholesome; nor is there any arsenick at all in them, though some have supposed the contrary. Nor yet is the mineral sulphur which they contain so hurtful as some have imagined; for those that are employed in the melting and preparing sulphur are as well, and in as good case as other people, and much better than miners of other kinds. Coals are so far from doing any harm, that they are rather beneficial, by drying up the too great humidity of the blood, and preserving the body from putrefaction; for it has been observed by Galen, that all bitumens, being kindled, mend the disorders of the air, by dispersing their too great humidity; which opinion has been hitherto followed by all physicians. Where the atmosphere is very moist, and full of watery vapours, so hurtful to human bodies, the burning of Coals is certainly very proper. In former times, when the plague and other infectious diseases were common, they used to burn bitumen to purify the air; and this is certain, that in London, since the burning of Pit-Coal has been almost universal, no plague has ever affected that city, nor any disease of that kind; and therefore there is no reason to be afraid of it, unless it be brought from other countries.

There are mines of Coals dug in various parts of England, which generally differ, in some respect, from each other; those brought from Newcastle, improperly called Sea-Coal, are remarkable for their being generally small, and caking on the fire. These are the best for boiling flesh, which others, in various parts of the kingdom, will not do, particularly in Staffordshire. Kannel Coal, which is dug up in Derbyshire and other places, is famous for its fineness, as well as hardness, though it will burn like a candle; there are now several things made with it, such as the tops of snuff-boxes, salt-cellar, and the like. It is also found in Staffordshire, and it is remarkable, that the choir of the cathedral church of Litchfield is paved therewith; that is, the black part with Coal, and the white with alabaster, which look like black and white marble. It will turn like ivory, into ink-pots and candlesticks; and some have their coats of arms carved thereon. The other Coals most used in London are brought from Wales and Scotland, and are valued for burning clear without a great deal of smoke.

## CHAP. XX.

### OF METALS and SEMI-METALS.

**ANTIMONY** is a mineral, consisting of sulphur and a mercurial arsenical substance, as is universally allowed by the chemists. It is solid, heavy, brittle, of the colour of lead, consisting of long shining streaks, and will melt in the fire, but is not malleable, in which it differs from a metal properly so called. There are several kinds of it, one of which looks like polished lead; but it is brittle, and mixed with a sort of crystalline stone. Another consists of slender shining lines, that look like needles placed



placed in rows, in some places, and in others without any order. A third kind is made up of broader shining plates; and a fourth of small lead coloured rods, which melts in the fire as readily as sulphur, on account of the large quantity of that substance contained therein: this is found in Italy, near Massa in Tuscany. There is still another kind, which may be distinguished by saffron coloured, or reddish spots dispersed here and there; and this is met with in the gold mines of Hungary. In short, there is scarce any part of the world where this mineral is not to be found, and though they seem to be of so many different sorts, yet their natures are nearly the same.

The Glebe of Antimony is generally mixed with a stony substance, which it is freed from by melting. They first break it into bits, and place it over the fire in earthen vessels, with holes at the bottom, under which there is another earthen vessel in the form of a cone, and when it is in fusion it runs through the holes, and leaves the dross behind. That which is hard, heavy, of a lead colour, with shining streaks, placed like rays, is accounted the best, and the Hungarian Antimony, for this reason, is chosen for medicinal purposes. The sulphur in Antimony may be readily perceived, not only from the smell, but from the bluish flame it emits while it is melting. Besides, when nitre is thrown into the crucible, containing red hot Antimony, it flashes in the same manner as with common sulphur.

It was formerly thought, that the sulphur of Antimony partook of the nature of gold; for which reason they employed themselves to little purpose in making experiments to extract the fine sulphur therefrom. Notwithstanding this, it is now generally acknowledged, that the sulphur of Antimony is exactly of the same nature as common sulphur, though all the reguline parts are seldom extracted from it; nor yet can that be called the pure sulphur that rises in flowers, when sublimed; for, though it takes fire like sulphur, yet the fume is of a whitish-yellow like that of orpiment. Besides, that it is not pure, may be known by its effects; for it will occasion violent vomiting, which is a certain sign that it is not entirely freed from the reguline particles. If you take white arsenick and mix it with half sulphur vivum, and afterwards sublime the mass, there will arise reddish flowers, which, when taken inwardly, have a very violent operation, and when they are set on fire emit a reddish fume; for there is such a force in mineral sulphur, that it will readily join with the arsenical particles, and carry them up therewith, when sublimed.

There is no substance in the world that yields so powerful a poison, and such efficacious medicines, as Antimony; however, when crude, it has no violent operation, and yet, taken in a proper quantity, may be given very advantageously in many cases, both to men and cattle. But if crude Antimony be melted in the fire, and mixed with the like quantity of nitre, by little and little it turns to a poison; and yet, if Antimony is mixed with one part of common salt, and calcined over a gentle fire for some hours, continually stirring it with a spatula, and afterwards edulcorating with water, there will remain an ash-coloured powder, which has no violent operation, but will promote a gentle sweat. Moreover, if you take four parts of Antimony, and four of salt of tartar, and melt them, and then pour them into a cone proper for that purpose, you will have the medicinal regulus of Antimony, which may be beaten into a reddish powder of extraordinary virtue. But if, instead of one part of the salt of tartar, two or three be made use of, and then melted, the regulus will be changed to a poison, which is occasioned by its being deprived of too much of its sulphur.

Crude Antimony, reduced to a fine powder, and taken inwardly, is very useful in several diseases; for it will dissolve the clamminess of the fluids, open obstructions, and is a good remedy in diseases of the skin. It is also excellent against the rheumatism, and will take away numbness of the limbs. The dose is about half a drachm. Antimony is also useful to various artificers; for pewterers mix it with tin and lead to make their pewter shine, and to give it the sound of silver; bell-founders mix it with other metals in making their bells; likewise the letter-founders constantly employ it in making their types. Add to this, that goldsmiths make use of it in purifying gold; for, when melted therewith, it will destroy all other metals, not excepting silver, and turn them into dross.

BISMUTH is a semi-metal, which will melt in the fire, but is not ductile; it is heavy, brittle, and differs from lead and tin in its colour and hardness; for it sometimes looks like silver, and sometimes is of a faint purple colour, not unlike regulus of antimony, though it consists of broader plates. Bismuth is sometimes found in so very pure an ore, that it stands in need of no other operation to fetch it out, than by breaking it in pieces. In the Museum of the Royal Society there are pieces of Bismuth sent from Cornwall under various names, which are so very rich, that, if a piece of it be only held with a pair of tongs against a clear fire, the Bismuth will run down in the form of melted tin, almost as soon as cheese will drop in toasting. Some call the ore of Bismuth the cobalt of Bismuth; because it contains the same principles as real cobalt, only in a different proportion. It is by some called tin-glass; and, when broken, appears to consist of small cubic particles, and these again of minute plates applied to each other. It is more brittle than zinc, though it differs little from it in external appearance, except in colour. It will cause metals, that will not easily melt, to be more fusible by a much less fire than they otherwise would. It mixes easily with any metal, and, according to the greater or less quantity added thereto, it renders them more or less white and brittle. But as Bismuth is easily destroyed, its mixture with metals, difficult to be melted, should be made in close vessels. It is very observable, that Bismuth melted with lead, tin, or silver, and afterwards amalgamated with Mercury, will pass through leather in much greater quantities than they otherwise would. When this powder is washed it is very white, and used by the ladies as a beautifier of the skin. It is of little use in medicine.

ZINC is a semi-metal, of a blueish-white colour, brittle, and yet somewhat ductile and malleable, though much less so than metals. It melts in a gentle fire, after which it smokes, and then sticks to the furnace in the form of exceeding white flowers. In a greater fire it burns, and emits a flame of a most beautiful green colour. All the Zinc that is prepared in Germany, especially at Goslaer, is obtained by sublimation, and not by melting; nor is it got out of any single ore, but out of such a confused mixture of different ores, that several other metals and semi-metals may be separated therefrom at the same time. There is no particular kind of sublimation for the extracting of Zinc; for it is collected during the melting of other metals, especially lead. The ores that yield Zinc are, by long and repeated roastings, freed from sulphur, and in a manner from arsenic, by the same operation.

There are certain substances that may be more properly called ores of Zinc, such as lapis calaminaris, or calamine; as also native cadmia. This is of a very irregular figure, sometimes spongy, and now and then solid. It is sometimes of a gold colour, sometimes red, and at other times grey; or of the



the mixture of them all. It is not very heavy nor hard; and, when broken in pieces, it immediately emits a flame of a greenish colour, and exhales a white, thick, copious fume, of a smell peculiar to itself, which condenses into very light flowers, at first bluish, and then of a greyish white. But care must be taken that the calamine be not mixed with a yellow sulphureous pyrites, or the white arsenical one, nor yet with lead ore.

Zinc, by some called Spelter, and by others Tuttenag, mixes readily with lead and tin, rendering them more brittle and less malleable. When it is by fusion mixed with four times the quantity of copper, it becomes a brittle metal of a gold colour, which is well known by the name of Prince's or Bath metal. The white flowers of Zinc, taken internally, promote sweating, and sometimes they will work upward and downward. The dose is from four grains to twelve. The making of Prince's metal is by melting three ounces of copper with half an ounce of Zinc, and when the mass is cold, it will appear of a fine gold colour, remaining ductile with a hammer.

COBALT is a ponderous mineral finely streaked, or sometimes granulated. It is often smooth on the outside, of a light greyish, and almost semi-metallic colour, and sometimes of a dark blackish dye. It contains a great deal of arsenick, as well as a certain fixed earth, which being melted with flints, and fixed salts, turns into a glass of a fine blue, called Smalt, which has been taken notice of before. Cobalt commonly contains bismuth; however, there are several minerals which go by the name of Cobalt, that have different properties from the former. That called the flower of Cobalt is finely streaked, lighter than the foregoing, and of a fine red purple colour, and belongs to this class; for it is a very arsenical mineral, and loses one half of its weight in the fire; but a great deal of bismuth may afterwards be melted out of what remains. This will likewise give a blue colour to glass, like the other Cobalt.

Native CINNABAR is a fossile metallick substance, heavy, but not very hard, which is either found pure, or mixed with stones. One of the sorts, when pure, is of a purple colour, inclining to red, and when ground, becomes of a beautiful red. There is another of a blackish, or of a liver colour, like blood-stone, and another yellowish. That sort of Cinnabar, which is mixed with stones, is often found in a fissile ash coloured stone, and sometimes in a very white metallick stone. It is sometimes met with under the form of pyrites, of a gold or silver colour. It is found in various places, as in Carinthia, Hungary, Bohemia, Italy, Spain and France.

It is known almost to every one, that it contains plenty of quick-silver, which is got from it by distillation, with the assistance of quick-lime or filings of iron. Sulphur may be extracted from it, though in a small quantity, if it be boiled in a strong lye, and separated from the quick-silver by pouring distilled vinegar thereon. Besides, Cinnabar may be made by art, not much unlike the native, as will be taken notice of hereafter. It is recommended by some physicians for internal use against the epilepsy, vertigo, madness, and disorders of the head; but the native Cinnabar is now very little used, the factitious sort being preferred.

QUICK-SILVER, or MERCURY, is a metallick fluid substance, cold to the touch, of a shining silver colour, very heavy and volatile, and readily mixes with most other metals. It is either found fluid in the bowels of the earth, in the chinks and veins of mines from whence it is collected, and washed with plenty of water to separate it from the earth, or it is dug up in glebes, consisting of a red mineral, sulphu-

reous, mercurial substance, called cinnabar. It is also found in the form of a slimy or stony glebe of divers colours, it being sometimes red, yellowish, brown, or of a lead colour. From this last, Quick-silver may be obtained by simple distillation, without the addition of any other matter, either by ascent in a retort, with a proper fire; or by descent, which is the common way, and is done in the following manner: They pound the mineral, and throw it into earthen vessels with a narrow neck, stopping it up with fresh moss from trees; then they place another over it, with a wider mouth, and bury them in the earth, with one of the mouths against the other, coating them all round with clay, and luting the mouths together, in such a manner, that the empty vessel is entirely hid under the earth, and that which is full placed above it. This is done in an open place, and many of them ranged in rows, after which they make fires all round them, by which means the minerals are heated, and the Quick-silver falls by drops into the lower vessel; but if the mineral abounds with sulphur, the Quick-silver cannot be extracted without the addition of some other substance, such as quick-lime and filings of iron, already taken notice of, as also wood-ashes.

Quick-silver exceeds all other metals in weight, except gold; for that will sink therein, while others swim at the top. The weight of gold, compared with Quick-silver, is a little more than four to three. It will mix with all metals, or semi-metals, though not without difficulty, with antimony, iron, and copper. It penetrates the metals, renders them brittle, and dissolves them; for which reason it is accounted by some the first matter of metals; but this opinion cannot be supported by experiments. It may be made to put on various appearances, which are all reducible to running Quick-silver again. It joins very readily with sea-salt, and turns therewith, by a gentle heat, into a white crystalline mass, called corrosive Mercury sublimate; but it will not do the same with nitre and vitriol. It will readily dissolve in spirit of nitre; but not without great difficulty with the oil of vitriol. It undergoes no change with alkaline salts; but it may be killed and fixed with salin-sulphureous bodies. Being ground some time with sulphur, it will turn into a very black powder, called Æthiops mineral; which, by the assistance of fire, may be sublimated into a very red radiated shining mass. Quick-silver being dissolved in spirit of nitre, and the acid spirit exhaled by fire, a red powder will remain at the bottom, called red precipitate; but if it be precipitated with salt of tartar, a brown powder will fall to the bottom, named precipitate of Wurtz; but with sea salt it will be white, and with lime water yellow.

The analysis of Quick-silver is very difficult, because it frequently flies away with the heat of the fire; however, if it be exposed to that heat in a glass vessel, with a long neck, it will, at length, become a grey powder, then yellow, and, at last, red; at which time it is somewhat more heavy than when fluid. But if this be exposed to a more violent heat, it will fly away, leaving only a little brown earth behind it.

Quick-silver, by the ancients, was accounted a poison, and Avicenna was the first who ventured to use it externally; but upwards of two hundred years ago some had the courage to use it internally, because they observed that it did sheep no harm, when it was given them by their shepherds to kill their worms. But Quick-silver cannot be said to have no bad effects; for those that are employed in digging for it, seldom continue four years without being affected with a trembling of the limbs and a palsy, of which they die.

However, Quick-silver has a remarkable virtue in opening all obstructions of the vessels and glands,



and of dissolving the thick gross matter contained therein, for which reason it is given in schirrosities of the liver, spleen, and mesentery, as well as in obstructions of the glands, and will also temperate the acrimony of the blood and humours. Quick-silver, not only taken inwardly, but applied outwardly in an ointment, will purge the body by stool, sweat and insensible perspiration; but its most remarkable effect is that of salivation.

That Quick-silver is counted best that is of a shining silver colour, very fluid, and, when held over the fire in a silver spoon, will fly away, without leaving any thing behind it. That which is of a livid colour, and does not separate into drops that are exactly round, is naught, and shews that it has been adulterated with lead or bismuth. However, it ought always to be cleansed, which may be done by squeezing it through shammy leather; but the best way is to distil it in a retort with quick-lime, pot-ashes, or iron filings. Crude Quick-silver may be given to kill worms, from a scruple to a drachm; and it may be rubbed on glass with sugar till it is dissolved, if a drop or two of oil of sweet almonds be added thereto. A pound of Quick-silver may be also boiled in pure water for an hour, and some of the clear liquor given to children for their common drink. It will kill worms taken inwardly, and lice when applied outwardly with an ointment. Crude Quick-silver is sometimes given to the quantity of two or three pounds, with oil, to force a passage through the guts in the iliac passion.

LEAD is of the least value of all metals, it being heavy, livid, and fouls the hand with a blackish colour; it yields little or no sound, and melts quickly in the fire before it turns red. Pure Lead is seldom found in the mines, but is extracted from ores of different kinds; for it is sometimes black, blue, yellow, or of an ash colour. It is sometimes full of shining minute particles, and sometimes again it is like a stone of a leaden shining colour, consisting of squares like dice, that lie in a white or reddish stone. The ore of Lead almost always contains a small quantity of silver; and particularly that of Cardiganshire in Wales has so much of it, that from two thousand pounds weight of ore, there has sometimes been extracted twenty pounds of silver.

When flints and the like are mixed with an ash or black colour, or are only marked here and there with veins and spots of the same, it is a sign that they contain either Iron or Lead. The green Lead ore is very rare; but when it is found it is variegated with a yellowish green colour and semi-transparent. It is likewise heavy but not hard, and one hundred weight of it yields from seventy to eighty pounds of Lead. There is also white and ash coloured Lead ore, but it is as uncommon as this.

There are several mines of Lead in Spain, Italy and Germany; nor is France without, though the metal be extracted with difficulty; but the best and richest are in England and Scotland. The method of obtaining the metal, is by placing the ore between strata of coals, and then when the fire is kindled the metal will flow; or pieces of wood may be used instead of coals or mixed therewith, according to the degree of fire that is required; for coals yield a more violent fire than wood.

The weight of Lead compared to Gold is as three to five. Lead is easily calcined and reduced to an ash coloured calx, which in a more violent fire turns yellow, and at length red, when it is called minium, or red lead, which may be easily reduced to Lead again, when mixed with combustible matter and melted. Lead mixed with nitre in a crucible will flash a little, and if the filings of Lead be thrown into the flame of a candle, it will tinge it with a bluish colour. From whence it appears, that there is a sulphureous principle in Lead, though in a small

quantity. When Lead is exposed to the focus of a large burning-glass, it will immediately smoke, and by little and little change into an ash coloured calx, then yellow and red, afterwards turning to a saffron coloured fluid, like oil, which in time will fly away in smoke; but if this fluid, before it is quite dissipated, be taken away from the focus, after it is cold, it will turn into a red, or reddish yellow mass, consisting of thin plates like orpiment, which are transparent and look like Talc. But if this be applied to the focus of a large burning-glass upon coals, it will immediately melt, and turn to Lead again. From hence it appears, that Lead consists of a glassy earth, not much unlike Talc with a sulphureous principle, that is inflammable, and not mixed intimately with the earth.

Lead will dissolve all other metals, except gold and silver, and carry them off along with it, or turn into litharge or fly off in smoke; for this reason it is used for the purifying gold and silver. It will not rust in water like iron or copper, but will dissolve in vinegar, spirit of vitriol, and spirit of nitre; and the salt which is obtained therefrom, when the spirits are evaporated, will have a sweetish taste; whence it is called sugar of Lead. It will also dissolve in oil and all fat substances. When Lead is reduced into a calx, though it emits a copious smoke, and loses much of its substance, it will increase in weight, in so much, that an hundred pounds of Lead will increase to an hundred and ten, when it is converted into red Lead; but if this afterwards be reduced to Lead again, it will not yield near an hundred pounds. When red Lead is melted with sand, it obtains a yellow gloss, not much unlike amber. Several preparations of Lead have formerly been used as medicines; but, as it is an enemy to the nerves, it is in a great measure left off, and ought to be entirely abandoned.

Litharge is generally made in the furnaces of metals, when Lead is separated from silver, or when Lead is made use of to cleanse silver from other metals mixed therewith; and it sometimes is of a silver, and sometimes of a gold colour, whence it is called litharge of gold or silver, though it does not receive its colour from those metals. Litharge is of great use in making plaisters of which it is the basis, being mixed with oil. It is a moderate drier, cleanses with a little astringency, and is proper to bring ulcers to a cicatrix.

Cerufs, or white Lead, is a sort of rust of Lead prepared in the following manner: The sharpest vinegar must be put into wide mouthed vessels in the summer-time, over which a plate of Lead is to be placed so closely, that nothing can escape out of the vessel: In about ten days the plate will be dissolved, and fall to the bottom of the vessel, from whence it is to be taken and dried, and afterwards ground in a mill. It is also made from the filings of Lead put into very sharp vinegar for ten days together; or a plate of Lead may be put therein, and taken out from time to time to scrape off the white part; and so again and again, till the whole plate is dissolved; then all the scrapings may be collected, ground, and made into masses with vinegar.

TIN is one of the softer and more ignoble metals; and is white, shining, brittle, sonorous, and crackles when bent. It is the lightest of all metals, and never existed naturally in a true metallick form. The richest Tin ore is of a black or dark colour, with many sides of an irregular figure, and a glossy surface. It is heavier than the ores of all other metals, which is somewhat strange, because Tin is lighter than all the rest. It is indifferently hard, and bears a quick fire without melting or growing clammy. But the most common Tin ore is of a dark, yellowish, rusty colour, and is very like the ore of iron; it is like the former in shape, and seems only to differ from



from it in its degree of purity. The garnet is a sort of precious stone, and now and then contains Tin; so that, upon this account, it is reckoned among the ores of this metal.

Tin, in Cornwall, is extracted from its ore, after it is separated from the stone to which it is connected, by pounding it with iron pestles, and in the mean while it is continually washed with water, that the earthy parts may be carried away therewith, and that the metallick particles may sink to the bottom. This gross powder, after it is dried, is ground with stone mills, and then washed, till it is quite freed from all foreign matter. Then it is dried and thrown into a furnace, mixed with charcoal, which being lighted and blown with bellows, the Tin will melt and fall to the bottom of the furnace; when the workmen, opening the small door of the furnace, suffer the metal to run into sand prepared for that purpose, where it forms large masses. The upper part of the Tin is so soft, that it is not fit for use without copper; and therefore they mix three pounds of that metal with an hundred of Tin. The middle part only requires two pounds of copper; but the lowest is so brittle, and so unfit for use, that they mix eighteen pounds of Lead with an hundred of Tin.

There is often an arsenical substance mixed therewith, which they call mundick, that is of a shining dark colour, and blackens the hands; but by the help of fire, it flies away in smoke. There is also another white saponaceous substance, which is soft, and may be dissolved in water at first; but soon after turns very hard. It is a kind of marl. The weight of Tin, with regard to gold, is as three to eight; and is easily melted and reduced into a whitish calx.

Tin will melt sooner than other metals, and will adhere to them very readily; for which reason copper and iron vessels are often tinned on the inside, to hinder them from rusting, and to prevent the bad effects of the copper. If it be mixed with these metals, it renders them more hard and brittle, and cannot be separated from them without great difficulty. Tin will not dissolve in any spirit, unless it be aqua regia; and its solution will tinge gold with an elegant purple colour.

The virtues of Tin are now well known as a vermifuge; for it will kill worms, taken either in powder or filings, from a scruple to a drachm for several days. Salt of Tin is made of that metal reduced to a calx, by exposing it to a reverberatory fire for two or three hours, and then throwing it into very strong distilled vinegar. This is recommended in hysterick fits, and is given from two grains to six. Mosfaick, or musive gold is made in the following manner: take of fine Tin one ounce, of Mercury revived from cinnabar ten drachms, and make an amalgama, which must be mixed with ten drachms of common sulphur, and an ounce of sal-ammoniack. All these, being finely ground together, must be sublimed in a strong fire for four hours, and a sort of cinnabarine substance will be raised to the upper part of the vessel; but at the bottom a kind of spongy substance of a gold colour will remain, which being washed in several waters, is called musive gold. It is of great use to painters, and in medicine has a diaphoretic quality. It is accounted good in hysterick and hypochondriack disorders, as well as for killing of worms. The dose is from ten grains to thirty. Some have supposed this to be a mercurial preparation, but falsely; for all the mercury is raised from it in sublimation.

IRON is an ignoble metal, remarkable for its hardness, and is of a whitish livid colour when polished; but before that it is blackish. When it is cleansed it is called steel. The ore of common Iron is of no certain form; but is most commonly of

a rusty colour. There is also an ore which is very heavy, and of a red bluish colour when broken. It is very rich in the best kind of Iron; and usually yields at the first melting, from sixty to eighty pounds out of an hundred weight. There is also a singular kind of Iron ore, of a pale yellowish colour, though sometimes grey; and sometimes of a kind of semi-transparent white. It will yield, when melted, about thirty pounds of Iron out of an hundred weight.

The HÆMATITES, or Blood-stone, is also a sort of Iron ore, and is very smooth on the outside, when the rust is taken off; but the inside is composed of convergent streaks. It is of a dark red colour, very heavy and hard, and is one of the purest of the Iron ores, with a small mixture of arsenick. Smiris, called in English emery, is the hardest of all the Iron ores hitherto known, and is almost as heavy as the blood-stone. It is of a brown colour, and certainly contains Iron, though it is not worth while to employ it for that purpose; and therefore it is used by workmen, when pounded, to polish steel and other things. Magnesia, or Magnanese, has no certain figure, is of a greyish black colour, and contains Iron; but it is not worth while to make use of it on that account, because it will not answer the charges. It is used in glass-houses to take away the green or blue colour of glass.

When iron is melted, it is formed into large masses, which are long and thick, and commonly called pigs. These are melted over again, and stirred with an Iron rod, in order to render them malleable. While they are yet red hot, they are placed under hammers, and by that means the heterogeneous particles are forced away by the repeated strokes. One sort of Iron differs greatly from another; but that which is toughest is best; and that which is most brittle is worst of all. However, all sorts of Iron are of the same nature; and they are only more or less tough in proportion to the earthy, vitriolic, and sulphureous particles mixed therewith. Iron being often melted and cleansed is turned into steel; though, in some, little labour is required for that purpose, and in others a great deal. When Iron is very good, they melt it in a furnace, and throw in gradually a mixture of equal parts of an alkalious salt, and filings of lead, with the raspings of oxes horns; then they stir the melted metal, and at length place it on the anvil, where they beat it into rods. Some iron will not melt over again, and then they take Iron rods as thick as a man's finger, and place them in a proper earthen vessel, alternately with strata composed of equal parts of soot, powder of charcoal, and raspings of oxes horns. When the vessel is full, they put a cover over it, and lute the joints, placing it in a reverberatory furnace; the fire is kindled, and increased by degrees, till the vessel is hot, and after six or seven hours, they let it go out of itself, in which time the rods will be turned into steel. When this operation is not perfectly performed, and only the outside of the Iron is turned into steel, in some parts of England, it is called case-hardening, and this is commonly done with the leather of old shoes.

Iron is the hardest of all metals; but it will become harder still, if heated red hot, and quenched immediately in cold water. The weight of Iron when compared with gold is as three to seven. Iron may be converted into rust, by moistening it with water, letting it dry, and often repeating the same operation; but it may be preserved from rust by being smeared with fat. Iron, calcined in a reverberatory fire, will turn into a darkish red, or purple calx; but being heated so hot as to be ready to melt, it will turn into scales under the hammer, which is nothing else but Iron half turned into glass. That part of the Iron, which in furnaces is turned into a



fort of glossy froth, is called the drops of Iron. This metal will dissolve in all sorts of acids; but alkalious Salts will not touch it.

Iron is a most useful metal, not only on account of the various mechanical uses it is put to, but on account of the many medicines it yields. Iron has two remarkable effects, namely, that of opening and binding; for it opens the obstructions of the liver, spleen, and bowels, stops loosenesses and hæmorrhages, and restores relaxed fibres to their due tone. For medicinal purposes, Iron is better than steel; and the filings of Iron alone, when ground small, is better than any other preparation of this metal whatever. The dose is from twelve grains to half a drachm, once or twice a day, in the form of a bolus, pills, or lozenges.

COPPER is one of the more hard ignoble metals, is softer than iron, and, when polished, is of a shining reddish colour. It will melt in the fire, and is so ductile that it may be beaten into exceeding thin leaves. It is more frequently found in its metallic form than iron, in various shapes; but its ore never distinguishes itself by any certain figure, for it is almost always irregular. But the finest colours of any kind, except the red and transparent, most commonly betray the presence of Copper; for this reason there is hardly any Copper-ore that is not mixed with Iron in a larger quantity than the ores of other metals commonly are. However, there is not so much in some as in others, and those that contain the least Iron are naturally more easily melted than the rest. The vitrious Copper-ore is of a darkish violet sky-colour, like that of a piece of steel that has touched a red hot iron. It is very heavy, and of a moderate hardness; but it is commonly variegated here and there with spots and grey veins. One hundred weight of this contains from fifty to eighty pounds of Copper. The Azure Copper-ore is of a most beautiful blue colour, and is not soft, but very heavy, and when broken shines like blue glass. This is most free from iron, arsenick, and sulphur; and a great quantity of excellent Copper may be extracted out of it with very great ease. The Green Copper-ore is like green crystals, and sometimes very prettily streaked; but in other things it has the properties of the former. The light dusky blue concretes, as well as the green, called by some Copper ochres, yield a great deal of very good Copper when they are pure, which may be known from their colour and weight; but those that are more light are mixed with unmetallic earth, and those that are yellow contain iron ochre; on which account they are the more difficult to be met with, and yield less Copper of an inferior sort.

The white Copper-ore has been hitherto found only in one single mine of Misnia, and is distinguished from the white pyrites by a somewhat yellowish colour.

The Sulphureous Copper pyrites is of a yellowish gold colour, with a light tinge of green, both within and without. When broken, the inside has a kind of granulated surface, and is easily beaten into powder. It contains sulphur and Copper in many different proportions; on which account its specific weight varies very much. If it is very rich in Copper, and at the same time is mixed with any quantity of arsenic, its gold colour becomes more yellow, and when it is broken, the surfaces are more smooth, neat and even. It is very often of a fine bright green, and blue on the outside, and between the chinks, though when broken, it appears of a different colour. When the Copper pyrites is mixed with a considerable quantity of arsenic, it will then look pale like the sulphureous Copper pyrites, and still whiter when there is more arsenic. However, it may be easily distinguished from the iron pyrites in being more heavy, and in

not sparkling so easily when struck with a steel. The yellow sulphureous iron pyrites belongs to this class, because it often contains a great deal of Copper, which may be known from its not being of a globular figure; for, when it is in that form, it is always destitute of Copper. There is likewise an unusual yellowish colour throughout its whole substance.

Copper is seldom found alone in its ore, for there are other metals along with it, as silver, iron, and lead; there is also a large quantity, generally speaking, of a combustible sulphur, not easily separated from it. That which abounds with most sulphur, must undergo different calcinations till all the sulphur is exhaled, and this the workmen call roasting. After this, the roasted ore is beaten into smaller pieces and calcined again, then it is beaten very small, and must undergo a third roasting, after which it will melt into a stoney red substance, which is called the stone of Copper. This done it must be roasted again, and then melted, when it will yield a black Copper. It must yet be roasted eight times, and then it will be thoroughly cleansed from all the sulphur.

There is a sort of Copper springs, out of which vitriol is made by boiling, and Copper may be extracted by precipitation, with the assistance of iron. There is one of this kind found near the town, called Smalnick, not far from mount Krapac in Hungary, in which there is Copper that will stick to iron when thrown into it; thus for instance, if you throw a horse-shoe into this spring, after a few days it may be taken out covered all over with Copper. There are Copper mines in various parts of the world, but the best and richest are in Sweden and Germany.

The weight of copper, with respect to gold, is a little more than four to nine; and if it be exposed to a moist air, it will contract a green rust. It has a disagreeable smell, and an austere acrid nauseous taste; it will, in time, dissolve in water, as well as in oil, and salts of all kinds will corrode it. Copper contains a portion of combustible sulphur, though not so much as iron, with a metallic red earth that will turn into glass. Copper will turn white with the fumes of arsenick or quicksilver; but it will not continue long. Being melted with lapis caliminaris, or zinc, it will turn of a yellow or gold colour, which is called Brass. Copper, on account of its ductility, is formed into various household utensils, and is melted into mortars, great guns, and the like; but it is seldom used in physic, especially internally, because it is of a poisonous nature; for which reason it is not safe to use it in pots, kettles, and the like, without tinning.

Verdigrease is the principal preparation, and is of great use to painters and dyers; but it is seldom or never given inwardly by physicians, though it is frequently used externally.

SILVER is a noble and perfect metal, of a white shining colour, sonorous and ductile, but not so perfect as gold. It is sometimes found in small masses of many different shapes, but most commonly like filaments and scales in several sorts of stones and earths, and in many sorts of land.

The Vitrean silver ore is of an irregular and uncertain form, is very weighty, and may be easily flatted with a hammer; for it is not much harder than lead, and is much of the same colour; for which reason it is often mistaken for lead. It melts presently, and soon grows red-hot. It consists of sulphur, and pure Silver, and above three quarters of it is Silver. The Horny Silver ore is half transparent, and is of a deeper yellow or brown colour, according as it consists of larger or smaller lumps. It looks like rosin, and is of an irregular shape. When carefully examined, it appears to consist of very thin plates; it is not very weighty or hard, for it may be easily ground; and when brought suddenly



to the fire, it crackles, bursts, and exhales a sulphureous smell, and sometimes burns lightly. This hard sort contains two thirds of Silver. The red Silver ore is sometimes of a lighter, and sometimes of a deeper scarlet colour; the first case is transparent like a garnet, and has been mistaken for transparent cinnabar; and in the second case it is of a deeper dye. It is heavier than the former horny ore; but bursts when brought near a candle or a mild fire, and the remaining part melts before it grows red-hot; then it emits a disagreeable smell of arsenic, together, with a thick smoke. It contains the same quantity of Silver as the horny ore just mentioned.

The White Silver ore is of a light grey colour of an irregular figure, pretty weighty, and very brittle. It has not only copper in it, but sometimes more of it than of Silver; for it differs from the white copper ore in nothing but in the quantity of Silver it contains. These are the principal Silver ores hitherto known, though many others are looked upon, by some, as such, because they contain a considerable quantity of Silver; but then there is always more of other metals along with them, and therefore they cannot properly be called Silver ores.

There are mines of Silver in many countries, as in Italy, Germany, Hungary, Norway and England; but the most remarkable are those of Peru and Mexico. In England the veins of lead always contain a small quantity of silver, particularly that in Cardiganshire. Silver may be easily extracted from lead, by melting it in channels, made with ashes in the furnace, and then blowing up the fire with bellows, till it turns into glass, sinks into the channels, and leaves the pure Silver behind.

Silver is harder than gold, but not so ductile, and is lighter than gold or lead, the weight, with regard to gold, being little less than five to nine. It will not rust, but will grow black by sulphureous vapours, and will dissolve in aqua fortis, but not in aqua regia. When it is mixed with common salt, and melted, it turns into a half transparent mass like horn, which is hard to be brought back to Silver again, because it is volatile, and in a violent fire will all fly away. When Silver is dissolved in aqua fortis it may be crystalized; and the crystals are very corrosive, and of an exceeding bitter taste; when applied to the skin, they leave an impression like that of a burning coal, and make an eschar of a black colour. The solution of Silver will turn any thing black, and therefore, when properly diluted, is often used to colour the hair. These crystals will melt in a very moderate heat before they grow red, and form a blackish mass; it is then proper for the use of surgeons, and is called the Silver caustic.

GOLD, the heaviest and most noble of all metals, is extremely ductile, and of a shining yellow. It is often found native, as it is called, but of no distinct figure, consisting only of small irregular masses. But there is a flint, in which Gold is commonly contained in very large solid masses. It is likewise concealed, but not so often, nor in so large a quantity, in a yellow and blue sort of stone, which some call the horny stone. Lapis Lazuli is a blue stone, and is often very elegantly variegated with very small specks of Gold; however, the quantity is not so large as in the former. Many sorts of gravels and earths often contain Gold; but they are seldom rich enough to pay the charges of extracting it. However, that kind of gravel, which is found in the channels of rivers and brooks, especially when they wind and turn very much, is richer in Gold than the rest. It has been found in the rivers of Scotland, of which medals have been made, especially at the time of the coronation of king Charles I.

Native Gold is not always found pure, for it is

often mixed with silver; and there has been no ore hitherto found, in which Gold constituted the greatest metallic part; so that no ore whatever can be properly called gold ore. However, there are Gold mines in Norway, Hungary and Guinea; but the richest of all are in Mexico and Peru. It is extracted from the substances in which it is contained, by roasting, pounding, washing, and mixing them with quick-silver.

Gold is not only the heaviest of all metals, but of all other substances yet known. It will not change with common fire, nor will it fly away in the focus of a large burning-glass, till it has continued there a long while. It will not rust, nor will it dissolve in any other menstruum, except aqua regia. It will mix readily with quick-silver, and turn into a soft amalgama. It may be calcined with common sulphur when it is made glowing hot, and held thereto. When gold is dissolved in aqua regia, and oil of tartar poured thereon, it will precipitate into a brown powder, which if heated at the fire, or lightly ground, will fly up with a great explosion and noise, from whence it is called fulminating Gold. All attempts to analyze this metal have hitherto been in vain. As for the use of gold in physic, notwithstanding the boasting of former chemists, it is little or none at all; for all its preparations have been hitherto found rather noxious than otherwise.

## CHAP. XXI.

### OF GEMS of all Kinds.

OF all the Transparent Gems, the DIAMOND is the hardest, the most beautiful and valuable. The best are those that are void of all colour; for if they are tinged with white, yellow or black, they are in some degree faulty, and considerably lower in price. It may be readily distinguished from all other Gems by its extreme lustre and sparkling, as well as the brightness of its reflections. If a little burnt ivory be laid upon mastic, in such a manner as to render it black, and the diamond be laid upon it, it will then reflect the most lively colours every way, which is a property belonging to this Gem, as all others will not bear the like trial; for, when they are laid upon the mastic in this manner, they either reflect no colours at all, or, if they do, they seem to be seen through a mist. There have been jewelers, who, designing to make other stones appear like diamonds, have taken a grain of wheat, and have pressed the oil out of it with a hot iron, and then have mixed it with lamp-black, or burnt ivory; then put it under the stone, but so as to leave a little room between it and the black tincture. Then the transparency, which is partly owing to the stone, and partly to the air, causes it in some degree to resemble a true diamond, inasmuch that some, though skilful in these matters, have been deceived thereby.

Those Gems that are most proper to counterfeit diamonds are the sapphire, the oriental amethyst, the topaz, and the chrysolite, because they are all hard, transparent, and may be deprived of their colour by means of fire; but this is most commonly done with quick lime, or the filings of steel; for when the Gem is buried in these, and put into a crucible with charcoal, it is put over the fire, and gently heated at first, and when the heat is increased the colour will vanish. When it has been in a sufficient time, they let the fire out by degrees, and do not take the stone out till it becomes lukewarm. If it is not entirely deprived of its colour, they repeat the operation as before; for if it was to be heated suddenly, or, when hot, immediately exposed to the cold air, it would certainly crack, or perhaps break entirely.



entirely. A topaz is more fit for this purpose than an amethyst, for this has been managed so artfully, that it could scarcely be distinguished from a Diamond by the best judges.

Diamonds sometimes receive their names from the places where they are found, as the Hungarian, Bohemian, and the like. Among these there are two differences worth observation; for some are found in the form of hexagons, and others almost round; but they differ greatly in hardness: those that have angles are softer, and are little better than crystal, as the Hungarian; those that are round, and in some sense resembling flints, are by much the hardest, and come pretty near the lustre and sparkling of oriental diamonds; but as they will not stand the trial of the mastick above mentioned, they cannot properly be called diamonds. The oriental diamonds are distinguished by the name of the places where they are found, for some of these are denominated from the old mines, and others from the new. However, they are not all equally hard, nor of the same colour, but they will stand the test of the mastick; and the harder they are the more they sparkle. Diamonds are not weighed like gold, but by carats, each carat consisting of four grains; and it has been said, that there was one found in Bisnagar that weighed an hundred and forty carats, that is, five hundred and sixty grains; it has also been reported, that there was one met with that weighed two hundred and fifty carats, and was of the size of a pullet's egg: However, the largest now known in Europe, is one that belongs to the great duke of Tuscany, which weighs an hundred thirty nine carats and a half; and that in the possession of the French king, which is equal to an hundred and six carats.

Diamonds are of such a nature that no fire will injure them, for when they have remained in one for several days, they rather come out with a more perfect lustre than otherwise.

The value of a Diamond arises partly from its sparkling and reflections, for it will imitate all the colours of the rainbow: and partly from its hardness, from whence it may be said to be almost incorruptible. Diamonds were formerly worn by kings, and other great persons only; but now they are very common, and may be easily purchased by people in moderate circumstances. A well polished Diamond formerly, of the weight of a pepper-corn, was sold for fifty shillings, but now it is not worth above two. A cut Diamond, weighing a carat, or four grains, has been valued at upwards of ten pounds; but now the price is extremely fallen.

With regard to the use of a Diamond, it not only serves for ornament, but, when reduced to powder, is extremely serviceable for polishing and cutting all other Gems whatever; and it is well known, that Diamonds themselves cannot be properly polished without it.

A Diamond seems to consist of several plates, laid one against another; for which reason, a skilful lapidary, with the point of a knife, can divide one into two or more tables. If one be placed in the focus of a burning-glass, with its plates perpendicular to the rays of the sun, it will receive no detriment; but if it be turned the other way, the rays will get between the plates, divide them, and afterwards turn them into a glassy substance, leaving not the least sign of the splendor of a Diamond.

The places from which Diamonds are brought, are the island of Borneo, and the kingdoms of Visapour, Golconda, and Bengal, in the East Indies, as well as from Brasil, in South America.

Tavernier, who travelled to the East Indies, chiefly for the sake of Diamonds, visited the places where they are chiefly to be found, in order to get the best knowledge of them he could. The first mine that he saw, was at a place called Carnatica, in the do-

minions of the king of Visapour, and at a place called Raolconda, five days journey from Golconda. This was found out above three hundred years ago; and about the place where the Diamonds are met with, the ground is sandy, and full of rocks and low trees. In these rocks there are several veins, sometimes half an inch, and sometimes an inch broad. The miners have small pieces of iron, crooked at the end, which they thrust into the veins to draw out the sand or the earth, which they put into vessels; and it is among this earth they find the Diamonds. But as these veins are not always straight, but sometimes ascend, and sometimes descend, they are obliged to break the rock to follow the course of the veins. After they have opened, and gathered as much sand as they can out of the veins, they wash it two or three times, in order to discover whether there are any Diamonds among it or not. This mine yields Diamonds of a very fine water; but they are often flawed by the bad management of their hammers in breaking the rocks to pieces. If the Diamond is good, they only polish the surface a little, because they are afraid of bringing it to a proper form that would lessen its weight. But if there be the least flaw or foulness, they give it variety of faces, or sides, in order to hide the defect. However, it is observable, that they would rather see a black speck in a stone than a red; and therefore, when there is one that is red, they put it into the fire, and then it becomes black. There are several men here, whose employment is to polish the Diamonds, and they have each but one wheel, which is made of steel, and about the diameter of a pewter plate. They apply but one stone at a time to the wheel, and sprinkle it constantly with water, till they have found out the way in which it will best work. This being found, they take oil and the powder of Diamond, which they never spare, because it is cheap here, that they may polish the Diamond the sooner. There is always a little boy, who continually supplies the wheel with oil and powder of Diamonds. However, they cannot polish the stones so well as the lapidaries in Europe, because as it is necessary to keep the steel rough by applying emery, or by filing it, and they are too lazy to do it so often as they ought, consequently the wheel will not perform the work so well, nor so soon, as those in this part of the world, where they take more pains.

The CARBUNCLE is a stone of a very deep red, with a mixture of scarlet, and has been formerly thought to shine in the dark like a lighted coal; but this is now known to be otherwise. It is said to be as hard as a sapphire, and to be found naturally of an angular figure, or smaller at one end than the other. However, as it is very uncommon, there needs no more to be said about it.

The RUBY is a transparent gem, of a reddish colour, with a small portion of blue, and cannot be touched by a file. The redness is not like that of vermilion, but of blood, or rather of cochineal, or kermes; but the less blue it has in it, the better it is. There are commonly said to be four kinds, the Ruby-cell, the Balas, and Spinel Ruby, which with the true Ruby make up the number; and the best are found in the island of Ceylon. In Pegu they are found in a river of that name, and the inhabitants try their goodness with their teeth and tongue; for they judge those that are coldest and hardest to be the best. They are said to mend the colour by the assistance of fire. They are usually met with in a stony matrix of a rose colour, and if they meet with one that is transparent, they then call it a Balas Ruby; but if it is otherwise, and has no resemblance of a gem, it is then the true matrix of Rubies, because it is formed, nourished, and increased therein. At first it is whitish, and assumes a red colour, as it ripens. It is generally found in the same mines with sapphires,



sapphires, and some of them are pretty large; for the Emperor Rodolphus had one that was as large as a small pullet's egg, and this was thought to be the largest that ever was seen in Europe.

When the value of a Ruby exceeds ten carats, it is thought to be very great, and is not exceeded by a Diamond. When a Ruby is deficient in its colour, that is, when it is not so red as it ought to be, some lapidaries endeavour to mend it, by putting a red foil under it, or glass of a beautiful red colour. Some have attempted to counterfeit a Ruby, with stones of a whitish colour, as a white sapphire, topaz, or crystal, by the assistance of a red foil, for then it will sparkle and seem to differ very little from a true Ruby; however, those that have judgment in stones will very easily distinguish it. There are other methods of counterfeiting this Gem, which we shall here omit.

The BALAS RUBY is the matrix of the true Ruby before described, and is supposed to have its name, from its being the house or palace thereof, for by some authors it is called palas on that account. This Ruby is of the colour of crimson, for it has a very little mixture of blue, and when it is polished, it is a very agreeable gem, and will sparkle almost as much as a true Ruby. It is found in veins of sapphire, and is to be met with in the same places as the other; though it is not so valuable by far. It may be adulterated like the true Ruby, and the fraud will not be so easily discovered.

The SPINEL RUBY is of a deeper colour than the true, but it has not the splendor, for which reason it is more easily adulterated. However, there are some so good as to come very near the value of the true Ruby, especially those that are said to be of the old rock, and are about half the value of Diamonds.

The RUBYCELL is a gem that seems to be between the Spinel and the Hyacinth, inasmuch that it is hard to say to which class it properly belongs. Likewise, they are sometimes exceedingly like Bohemian Garnets, and are not known from them till an experiment is made in the fire; for these will bear it without the least loss of colour, whereas the Ruby-cell will either lose or change it. They are not near so valuable as the Balas or Spinel.

The GARNETS have by some been taken to be carbuncles; for, when exposed to the sun, they will shine like a lighted coal, and much better than a ruby. They are brought from the East and West Indies, and from Ethiopia, where they are of three kinds; for some are darker than the rest, being of a blackish blood colour, and yet they will sparkle indifferently well. When a white foil is placed under them, they are of such a fiery colour, that some have mistaken them for true carbuncles. Many of these are large, some having been found bigger than a hen's egg. Another sort is of the colour of a hyacinth, and, if it was not for being redder, might be taken for a true gem of that kind. When it has a yellowish tinge, it may be placed among the class of hyacinths, and will be that stone called in Italy Jacintha la Bella. These sometimes resemble other gems so much, that even the lapidaries themselves are not certain what they are. Another sort of Garnets are of a violet colour mixed with red, and these are better than the former, inasmuch that they are called by the Italians Rock-Rubies.

The OCCIDENTAL GARNETS are often of a fainter colour, and particularly the Spanish, inasmuch, that they appear like a pomegranate seed, and are pretty large. Some are of a yellowish red, and will not change in the fire, particularly the Bohemian, and they are all free from flaws. These are more valuable than the oriental, on account of their resisting fire, and resemble real carbuncles. These are found in the fields almost every where by the

country people, without any matrix; they are generally of the size of peas, and are carried to Prague to be sold. At first they are so black on the outside, that no redness can be perceived, till they are held up to the light. Others are found in Silesia, but these are rough, and generally full of flaws, inasmuch, that they are seldom transparent. If a Garnet be exposed to the focus of a large burning-glass, upon charcoal, it will be reduced to a metallick mass of the nature of iron, for it may be attracted by a loadstone.

The HYACINTH is so called, from its being of the colour of a flower of that name, which is of a yellowish red. There are four kinds, as being of so many different colours; the first is as red as vermillion, and pretty nearly resembles Bohemian Garnets, but without any mixture of blackness. These are more valuable than the rest, and may be placed in the class of carbuncles. The second sort are of a reddish saffron colour; the third are like yellow amber, and could not be distinguished from it, unless by their hardness, and their want of electricity. These are of little value, no more than the fourth sort, which look like white amber, and are worst of all. The Hyacinth is found in the East and West Indies, as well as in Silesia and Bohemia.

The AMETHYST is a transparent gem, of a violet colour, arising from a mixture of red and blue. However, they are of different colours, for some, as the oriental, have a mixture of yellow, and some are purplish like red wine; but the best sort are those that shine most like a carbuncle, and are so hard that they may be turned into a sort of diamonds, so as to deceive the most skilful lapidaries. They are found in India, Arabia, Armenia, Ethiopia, Cyprus, Germany, Bohemia, and Misnia; but they are generally as soft as crystal, and are not in very great esteem. The oriental are hardest; if they are without spots they are of the greatest value. They are found of various sizes, and in various shapes, from the bigness of a small pea, to an inch and a half in diameter. They are adulterated with mastick tinged of a violet colour, placed between two crystals; but the Germans do not think it worth while to counterfeit them, because they are pretty common.

The SAPPHIRE, which is a hard gem of a blue or sky colour, is very transparent and sparkles very much; but some of them are whitish, and others of a deeper blue; and when they are destitute of all colours, they are called white sapphires, and are so like diamonds they may very well supply their place. They are either oriental or occidental; the former are brought from Calicut, Cananor, Bisnagor, and Ceylon; but the best are found in the kingdom of Pegu. It is very subject to flaws, and yet is so hard that a file will not touch it. The colour may readily be taken away by fire, and then it will be converted to a sort of a diamond, inasmuch, that when it is set in a ring, it can hardly be known from one by a skilful lapidary. The value of a Sapphire is derived from its colour, purity, and magnitude; for if it has no flaw, and is of a deep colour, continuing transparent at the same time, it is then the best. It has been common to counterfeit Sapphires with a bit of blue glass placed between two Bohemian diamonds. Some tinge glass of a blue colour, and sell it to ignorant people for a Sapphire. They are found in various sizes; but seldom so small as other gems, and yet never more than three quarters of an inch in diameter; but the usual size is between the sixth and the tenth of an inch. The shape is very uncertain; for it is sometimes in one form, and sometimes in another.

The OPAL is a most beautiful gem, for in different lights it shews all sorts of colours, which is occasioned by the different refraction of the rays of light.



light. There are four kinds of this stone, the first of which is transparent, without any opacity, and yet reflects all the colours of the rainbow. Another sort is black, and yet sparkles so much that it appears like a carbuncle; but this is exceeding scarce and consequently highly valuable. The third species reflects various colours; but the yellow is predominant, and consequently this is not so valuable as the first sort. Almost all these are brought from Hungary, and are in very good esteem. The fourth sort is a bastard Opal, and is of the colour of the crystalline humour of the eyes of fish; for it is a little transparent, and is nearly of a bluish milk colour or yellowish; and when it is turned to the light, it seems to shine at the farther edge, by means of the reflection of the light. It is by some called an asterites, or the star stone, because within it may be seen a sort of star, which changes its place as it is turned differently to the light.

The CATS-EYE, by most jewellers, is not placed among the opal kind; but is thought to be a peculiar gem, and therefore will require a more distinct consideration. The opals of the first and second kind are seldom to be met with very large; but they are of very great value; for one in the possession of a Roman senator was said to be worth twenty thousand ducats. Those of the third and fourth kind are sometimes met with pretty large; for one of these that reflected various colours was of the size of a walnut, and was valued at two hundred crowns. All sorts of opals are found in the East-Indies; but those of the ordinary sort are to be met with in Cyprus, Egypt, Arabia, Natolia and Hungary; and in this last place some of the first sort have been found in opal stones, though very seldom. There have been also some lately found in Denmark, and they are all contained in a soft stone full of black, yellow, and fallow coloured veins. With regard to the value, it has been generally thought to equal that of sapphires. They cannot be counterfeited like other gems with a double glass, nor yet any other way.

The EMERALD is a green, shining, transparent gem, and has a very agreeable appearance. It is of two kinds, the oriental and occidental; the oriental are very hard, and of a meadow green colour, which never changes in any light. They are quite transparent, and are in very great esteem, they being of the very best kind. They are brought from the East Indies, as well as Tartary, Egypt, and other countries at a great distance from thence; however, they are very scarce, and there are very few of this kind seen in England. But the American Emeralds are more common, and are found principally in Peru in the earth of the mountains. These are of a very pleasant green, though they are but dull in comparison of the former; for they are neither so transparent, nor so sparkling, nor yet so hard; and comparatively the value is but small, with regard to the former. The European come principally from Silesia, and there are coloured crystals found in Germany, that commonly go under the name of occidental Emeralds. The oriental are seldom met with above the size of a hazel nut. When an Emerald is put in the fire it kindles like brimstone, and the green colour flies off in a flame, after which it looks like a bit of crystal. Hence it appears, that gems in general consist of two parts; namely the crystalline, which is fixed, and the sulphureous, that is volatile. An Emerald is not quite destitute of medicinal virtues; for what is done in the fire, may, in some measure, be performed by the heat of the stomach, and by the digesting fluid. However, it must be acknowledged, that the virtue of any sort of gem is not sufficiently apparent hitherto. The best kind of Emeralds have always been in high esteem; but these are exceeding scarce, as has been

observed: the occidental being more common, and by far not so good, are of little value with respect to the former. An Emerald may be counterfeited various ways, but the best is by melted crystal glass, with a small addition of red lead. By this method, practised judiciously, counterfeit emeralds may be produced as good as those of America.

The PRASIUS, or PRASSITE, is by many thought to be the matrix of an Emerald, and perhaps not improperly, because it is sometimes found within it: for the greener parts that are transparent, and without any mixture of yellow, may be properly called Emeralds; and those that are of a golden yellow, may have the name of Chrysoprasites. The colour of this gem is like that of leek, or a mixture of yellow and green. It is but semi-transparent; on account of the clouds that are visible in it; and sometimes it has a mixture of red, white, or black, according to the various stones to which it has been formed, such as jasper, crystal, and the like. There is one sort altogether green, another more yellow like dried fern, and a third is very little green, with a great deal of whitish yellow. This last kind is semi-transparent, and ought rather to be placed among the nephritic stones. This gem is very common, and so large, that statues have been made therewith, and therefore it can be of little value. The Chrysoprasius is nothing more than a Prassite, that has the colour of gold mixed with the greenness of a leek, and it looks very prettily, though it is not of much value.

The SMARAGDOPRASIUS is a gem between a Prassite and an Emerald, and is of a grass green colour, without the least yellowness in it; but it is not so green as an emerald. It is sometimes, though very seldom, almost transparent, and is called by some a bastard emerald. These stones are found in Bohemia and the West Indies. The Bohemian is generally opaque, and nearly resembles Roman vitriol. These are said to be the stones that the native Americans near the river of the Amazons wear in holes of their lips, in pieces about the length of a man's finger. Some take this to be the true nephritic stone; but this is doubtful, as well as its virtues.

The CHRYSOLITE is the topaz of the ancients, and is a transparent gem, shining with the colour of gold. It is of a fainter green than the emerald, and has somewhat of a yellowish tinge. Some take it to be the matrix of the emerald, and by many it is confounded with a chrysoprasius. This stone will not stand the test of the file, and sometimes there are such large pieces of it that statues may be made therewith. The topaz of the shops is the Chrysolite of the ancients, and is a transparent stone of a shining gold colour without any mixture. It is of two kinds, the oriental and the European; the first of which shines like pure gold. The European are as soft as crystal, and have a mixture of blackness with the gold colour; and there is sometimes so much of it, and so little of the yellow, that if it was not for the blackness, it could not be distinguished from crystal. Sometimes pieces of these have been found to weigh twelve pounds, and there was one brought from Bohemia that was two ells in length, and near half an ell broad. These stones may be counterfeited in the same manner as the rest; but the best way is to put a quarter of an ounce of saffron of iron, and a little red lead into a pound of melted crystal glass, or if one part of calcined crystal be added to three of lead, and then kept for a whole day in a furnace, a topaz will be formed without any other addition.

The BERILL is a gem of a bluish green like sea water, for which reason it is called by the Italians Aqua Marina. When it has rays of a gold colour, or the sparkles are of that colour, it is called a Chrysoberill,



Chrysoberill, and some place it in the same class as the chrysoprasius. All these stones are transparent, and have but a faintish colour, for when this is more deep, they are taken for other gems. It is found of various sizes and of different shapes, that are seldom more than a third of an inch in diameter; and the value is always in proportion to the fineness of the colour. It may be counterfeited by reducing burnt copper to an impalpable powder, and melting it with crystalline glass, or calcined crystal, in the proportion of one drachm to a pound of glass.

The ASTERIA, called by the Italians Girasole, is a sort of opal; only it is harder, and consequently may be placed by itself; especially as it may be distinguished from an opal very easily. The harder it is, the better it reflects the image of the sun, and so agreeably, that it is by some called the gem of the sun. This stone is transparent like crystal, but much harder. It has been named by some the cats eye, because the sparkling is sometimes greater and sometimes less. It differs from the eyes of Belus termed by the Italians Bellocchio, because it exactly imitates the iris of the eye and pupil. Specimens of this have been taken from the matrix of opal, and when exposed to the sun, they emit sparkles like so many small stars.

We now come to the semi-transparent stones, among which the SARDIUS, or CORNELIAN, is reckoned the chief. By some it is called the Carnelian, because it is of the colour of raw flesh, for *Caro* is Latin for flesh. However, it is more of the colour of bilious blood. It is semi-transparent like the washings of flesh, and is called by Pliny *Sarda*. It was in common use among the ancients, especially for seals, as it is at present. It was first found by the inhabitants of Sardis, a town of Lydia in Asia Minor, and from thence was carried to Rome; but there was a very good kind found near Babylon in the heart of a stone. There are three kinds of it; namely, the red, the demium (which looks duller or fatter than the former) and that which seems to have a mixture of silver films. Those of the East Indies are most transparent; and the thicker or fatter sort is brought from Arabia. It is also found in the West Indies, as well as Silesia, Bohemia, and many other places. There are three kinds of Cornelians, the first of which is the red, now taken notice of. The second is of a faint blood-colour, and semi-transparent; and the third is of a yellowish red. It is usually found in other stones. It was formerly in high esteem; but since other and better gems are more common, it is of little value, being chiefly made use of for seals, as was above hinted.

The SARDONYX seems to be of a middle nature, between the cornelian and the onyx, which its name seems plainly to imply. It is generally tinged with white, black, and blood-colour, which are distinguished from each other by circles or rows, so distinct that they appear to be the effect of art. There are many kinds, and great diversity in the colour of these stones; but the greater variety there is of these last, the more they are valued. They have sometimes purple, blue, rose-coloured, and yellow circles, whose ground is black, especially the Arabian; for in the East Indies it is of the colour of horn. When the circles are not distinct, but as it were separated, and of the colour of honey, they are of no great value. The best sort is brought from the East Indies, and the next to that is the Arabian. It is found also in Germany, Bohemia, Silesia, and the neighbouring countries; but it is seldom clear, nor are the circles distinct like those of the East-Indies. There are pieces of the Sardonyx found so large, that drinking vessels may be made therewith.

The CHALCEDONY is placed by Pliny in the

class of rubies of a darker aspect, and yet paler than a carbuncle; but this is evidently the characteristic of a garnet. This gem is generally of the same colour throughout; though it is sometimes a little clouded. It is semi-transparent, and so hard, that it is seldom or never made into seals. It was formerly placed in the class of onyx's, of which it is a species, and was called the White Onyx. It is either Oriental or European; and those that have a mixture of a faint colour are hard and beautiful, and are taken for the oriental. Such as these have a purplish or bluish mixture, or a redness like that of lac. Those that are earthy, or of a dusky whitish colour, are of little value, and are met with in all parts of Germany. There are always some found in the Netherlands. Those that are tinged with a disagreeable reddish or yellowish colour, though they are not of the oriental kind, are in higher esteem than the last. Some of these have been seen in Lorraine of a surprising magnitude, and when they have been struck with a hammer have yielded a ringing sound. Those are accounted best of all, in which there is blue, white, yellow, and red confusedly mixed together, and which exposed to the sun shew all the colours of the rain-bow. This also served to make the Myrrhine vessels of the Romans, which were so highly valued, and at this day they are wrought into cups, heads of great men, and the like; but its chief use is for seals, because the wax will not stick thereto. Some of these stones, brought from the East Indies, are almost transparent, and of a whitish pale colour, and some are tinged with white circles or zones. They are now of little value, except when the pieces are large and fit for the making of figures.

The ONYX, which in Greek signifies a nail, is so called from its likeness to the colour of the nail of a man's hand. It is seldom transparent, and generally consists of a mixture of black and white colours, which are quite distinct from each other. The horny colour is often marked with whitish veins or zones, somewhat resembling an eye. The kinds of Onyx are distinguished, either from the places where they are found, or from their different colours. The Arabian Onyx is black with white zones, and a variety of other colours. When the white zone in carving any figure is placed on the top, and the black serves for a ground, it is called Cameo by the jewellers, as if it was a distinct gem. When it is white, it is called a Chalcedony, before described. Some Onyx's are quite black, others are tinged with fallow colour, yellow, whitish, bluish, and horn colours, mixed in an agreeable manner. They have all zones or streaks, which distinguish one colour from another. The Onyx has been sometimes found so large, that columns have been made therewith; and there are now six of this kind in St. Peter's church at Rome. This likewise served to make the Myrrhine vessels before taken notice of, and is now made use of for cups, statues, and the like. It is of greater value than the sardonyx; those are the best which are bluish at the top, and blackish at the bottom; and these are much sought after by the Jews. This stone does not stick to wax, and therefore is as often now, as formerly, made into seals.

The AGATE is very like an onyx, with regard to colour, but it differs from it in being adorned with zones, whereas the Agate has none; but instead thereof there are lines or spots of various colours, in such a manner as to represent the pictures of different things, as woods, rivers, fruits, flowers, herbs, and clouds, though not very distinctly. An Agate differs from a Jasper in hardness and smoothness; for though the jasper has all the same colours, it is softer, and consists of rougher particles.



The White-veined AGATE, with delineations of trees and mosses, is most commonly known by the name of the Mocha stone. It is of a very firm compact and fine texture, though it is found in the shape of a flinty pebble-stone. The sizes are various, being sometimes only one, and sometimes eight inches in diameter. The veins of this stone are very beautifully disposed in different figures; but generally there are many concentric irregular circles drawn round from one to three points in various places. They are commonly a little whiter than the ground, though sometimes they can scarcely be seen. Those of this kind are of the highest value, and contain the figures of trees, mosses, sea-plants, and the like, which were just taken notice of. Some have supposed that these are only petrifications, and that real mosses and sea plants were included therein; but this is a mistake, which is evident from hence, namely, that the real things which they represent were never met with so diminutive as their images in these stones: for none can be so foolish as to imagine, that there ever was a perfect tree no more than half an inch high. These figures are generally black, or of a dusky colour, and appear with great advantage from the whiteness of the stone. This kind of Agate, when it is perfect, is only found in the East Indies; but there are some of an inferior sort to be met with in Germany. They are called Mocha stones, because they have been brought from the East Indies to Mocha in Arabia, and from thence transported into Europe. However, there are some that will not allow them to be found in the East Indies; which if true, they may as well have the name from the place near which they are found; or at least they may be brought to Mocha from other parts of Arabia, or even Asia.

The Dull Milky AGATE is not so valuable as the former, though it is of a very firm texture. It is found in the shape of common flint stones, and is from one inch to ten in diameter. It is of the colour of milk, or rather like that of cream; and, when it is broken, has a smooth, glossy surface. It is more opaque than the former, and yet it will bear a very fine polish. This species is common on the shores of the rivers in the East Indies, and there are some of less value met with in Germany and Bohemia.

The Lead-coloured AGATE, with black and white veins, is of a very fine, firm, compact texture, though it is found, like the former, in the shape of common flint stones, and of as rugged a surface. The ground is of a pale bluish grey, or rather of a dove-colour, and is often without variation, though it has sometimes black and sometimes white veins, which are generally towards the centre of the stone. This resembles an onyx very much, but is certainly distinct from it. It is very hard, and will bear a fine polish. It is found in the East Indies, as well as in Germany, where they make cups and snuff-boxes therewith.

The Flesh-coloured AGATE is not so valuable as any of the former, though within it has a pretty firm compact texture, and is from one to ten inches in diameter. The flesh-colour is very faint, and almost whitish; but yet it is never entirely wanting. Sometimes it has no veins at all, and at other times it abounds in veins, spots, or clouds. The spots are generally very small, about the size of a pin's head, notched at the edges; though sometimes they are much less. When broken in pieces it is very smooth and glossy, though it is not always of the same transparency. It is found in Germany, Bohemia, and Italy, and is worked into various sorts of vessels: it is also often made use of instead of gun-flints.

The Blood-coloured AGATE is more beautiful than most of this class. It is always of a deep blood-

red colour, sometimes throughout, but more frequently variegated with a pale blue and brown. The blue always surrounds the red, and inclines to the colour of whey; but it is in no other part of the stone. The brown is of the colour of horn, and generally appears in irregular veins, sometimes in such plenty as to make the ground to the stone, and the red with its blue edges only the variegation. It is not very common, though it is found in the East Indies, America, and some parts of Germany. It is chiefly used for the tops of snuff-boxes.

The Clouded and Spotted Flesh-coloured AGATE is of a very fine close texture, though it is subject to flaws and cracks when the pieces are large; for which reason the lesser stones are most esteemed; but, in general, it is in very little esteem with us.

The Red AGATE, variegated with Yellow, is of the colour of red lead, has a fine pure equal texture, with a smooth regular surface, and is commonly found in the shape of a pebble stone. It is from one inch to four or five in diameter, and its ground is of a paler red with one that is deeper, disposed in concentric veins round from one to three points; but this does not appear without close examination. Besides these it has irregular bright yellow blotches, that are never intersected by the veins, but are either within or on the outside thereof; and they are always extremely short, being never above a sixth part of an inch in length. It is very hard, and will bear a very fine polish; it is found in the East Indies, though it is not very common there.

The Yellow AGATE has been found from one to seven inches in diameter in various shapes and sizes; but they are all of a very firm compact texture. It is sometimes of the same colour throughout; sometimes consists of irregular veins, and at others has a pale and almost white ground, veined and spotted with a strong yellow, exactly resembling that of a fine yellow bees-wax. It is very hard and capable of a fine polish; but the degree of transparency differs greatly, for sometimes it is as much so as any of the rest, and at others it is almost entirely opaque. It is found in the East Indies and America, as also in Germany, though not very good. In some places it serves to make knife-handles and the like.

The Pale Yellow AGATE, variegated with white, black, and green, is called the Leonina, from its likeness to a Lion's skin. It is more variegated than the rest of the stones of this kind, and has a fine compact close texture, though it is found in very irregular shapes, with a rugged outside. It sometimes seems to consist of an irregular mass, made up of the above-mentioned colours, and at other times is distinctly clouded therewith, and sometimes again it has black and green veins in the form of concentric circles running round a point. The ground is always of a pale yellow, but very differently disposed; sometimes more, sometimes less. Likewise in some, one or more of these colours are wanting, while others contain them all. The green is like that of Jasper, and the black is inclinable to brown. It breaks with some difficulty into pieces, with fine smooth surfaces, and is brought from the East Indies; but it is not commonly known, because it is very scarce.

The Blackish Veined Brown AGATE is found in stones that have a pretty smooth surface, though of an irregular shape, and from two to seven inches in diameter. The brown is pretty deep, and is finely clouded, spotted, and veined with a colour that is almost black, and the veins are generally paler and browner than the other variegations. The veins are disposed in irregular concentric circles, and the innermost are generally broadest. There have sometimes been vegetable substances found in the middle of it, such as the slender roots of moss, or of crow silk.



filk. It is capable of a very high and beautiful polish, and is commonly cut into seals, buttons, heads of canes, knife-handles, and the tops of snuff-boxes. It is frequently adorned with factitious colours, which sink into the substance so much, that they appear like the natural veins of the stone; and then it is of great value.

The Greenish Brown Variegated AGATE seems to be of a middle nature between Agate and Jasper. It is a beautiful species; and is found in roundish stones with a smooth even surface, from two to six inches in diameter. Its texture is very firm, and it is sometimes of the same colour throughout, being only distinguishable from the true Jasper by its hardness. But it has most frequently a brownish green ground, variegated with irregular concentric circles, of a red, or of a finer green; it is also found irregularly clouded and spotted, with the same or other colours, as white, flesh colour and yellow. It is never entirely transparent in those that are clearest; and it is found in different parts of the world, but not equally good; for the European are the worst, they being more coarse, soft, and opaque than those of the East or West Indies.

The JASPER differs little from an Agate, only it is softer, and will not bear so fine a polish, because it consists of grosser particles; besides, it is not so transparent, and is most commonly green; and the nearer it comes to an Emerald, the higher is the value. However it is of other colours, and on that account is divided into different species, among which are included the Nephritic Stones.

The White NEPHRITIC STONE has a very fine, compact, firm texture, with a smooth glossy surface, and is of various sizes; but the common sort are two inches in diameter. The shape is very irregular like a common flint, and it is naturally of a fine white, with great brightness and transparency. It has sometimes a bluish tinge, which makes it appear of a deep pearl colour, and upon that account is more valued by some; but when it is yellowish, it is not in great esteem. It looks pretty much like marble, but breaks into fine glossy bits, and is considerably heavy, as well as very hard. It is found in many parts of America, particularly near the river of the Amazons. It is often cut into small cups and other toys, which are extremely bright.

The Green JASPER is a bright semi-transparent stone, and of a close, very hard, irregular texture. It has been found in masses of many feet in diameter, sometimes no bigger than a horse-bean. It is of a deep beautiful green, and almost always of the same colour throughout; though it has been sometimes met with clouded with white. It is externally pretty, bright and glossy, and breaks into smooth pieces, seeming to be of a texture between flint and marble. It is considerably heavy, and its very great hardness renders it capable of a fine polish.

The Soft Dusky Green JASPER is not so heavy nor so valuable as the former, and is generally found in stones of a flat shape, from two to five inches in diameter. The surface is pretty full of superficial cracks, and the colour is always dull, with sometimes a bluish and sometimes a brownish cast. It is so common in Guernsey, that it is frequently brought over with other things, and is often made use of to pave the streets of London.

Hard Bluish Green JASPER, variegated with red, is called Oriental Jasper. It may be easily distinguished from all others by its blood-red spots, and it has a very firm and compact texture. It is found from two to six inches in diameter, and has a roughish irregular surface, but has no determinate shape. It is not at all transparent, except in very thin pieces, and is sometimes veined and clouded as well as spotted with red. It is most commonly

known by the name of Blood Stone, and will take a very fine polish. It is common in Egypt, Africa, and the West Indies, and is by some termed the matrix of the Emerald. It serves for various purposes, particularly cups, snuff-boxes, and seals.

The Hard Whitish Green JASPER is the nephritic stone of the ancients, and is generally of the same colour throughout. It is harder than a Jasper, and the surface seems as though it was smeared with oil. It is sometimes of a whitish green, which last colour is sometimes yellowish, and sometimes bluish; but generally it seems to be composed of greenish white, yellow, bluish and black colours; but not all at the same time. The common sort are from two to five inches in diameter, and the shape is very irregular like common flints. It is found on the surface of the earth, and in the beds of rivers in many parts of America, where they form them into the figures of birds, beasts and fishes.

The very hard Yellowish Green JASPER is more dull and opaque than the former, though the texture is very firm and close. The colour is properly a mixture of green and yellow, in which it differs chiefly from the former, and in its transparency.

The Bluish Green JASPER, variegated with blue and black, is a kind of nephritic stone, it being of a middle nature, between the oriental green Jasper, the green nephritic stone, and the marble Ophites. The texture is firm and compact, and is found from four to six inches in diameter, and generally of a flatish oval shape, with a rough surface. The colour is usually very agreeable, and is always made up of a mixture of green, grey and blue, which are sometimes paler and sometimes deeper, as well as inclining to other colours. Sometimes they are so blended, as to render it of one colour throughout, and sometimes they are disposed in clouds, spots and veins; and then the colours are as distinct as in the blood-stone. It is found on the banks of the great river of the Amazons in America.

The Hard Greyish Green JASPER is a very hard stone of a greyish green colour, approaching to that of an olive; but the green is of three different kinds. The finest sort is brought from the East Indies, and the Turks and Poles make handles of it for their sabres and cutlasses. It is capable of a very elegant polish, and is found from six to ten inches long, of an unequal shape with a rough surface. It has little or no degrees of transparency, but it is remarkably heavy, and is found only in the East Indies.

The Dull Deep Green JASPER is of a green colour like mallows, from whence it has its name, for *Malache* in Greek signifies Mallows. It is generally adorned with white veins, and the bluish colour that is intermixed is very ornamental; but when there is any black therein it debases the value. It is pretty heavy, and will take an excellent polish. It is brought from the East Indies and America, and is also found in Germany, and some other parts of Europe but is not so good as the former.

The Dusky Green JASPER, variegated with white and flesh-colour, is a rough, coarse and rugged stone, which is found from thirteen to eighteen inches in diameter, is generally of a roundish or oval shape, and always flatted more or less. The texture is firm and compact, and it is often mixed with a variety of colours disposed in a different manner. It is always green in part, and has often thin transverse veins of flesh-colour and white, with spots and clouds of black. The green is not always the same, for it is sometimes deep, and at other times light; but generally the variety is very agreeable. It is very hard, and for that reason will bear a good polish. It is common in the island of Jersey, from whence it is brought among other stones to pave the streets of London; but it might be put to a much better use.



**Hard Variegated Purple JASPER** has been called the rose coloured Jasper by Pliny. It has a smooth, fine, hard texture, though the surface is rough and unequal like a flint stone; it is sometimes fifteen inches in diameter, and is variously tinged with colours, in which the red and blue are always predominant, which when uniformly mixed render it purple; but where it is blue, it is always most bright and transparent. It is brought from various parts of the world, as the East and West Indies, Egypt, Germany, Bohemia and Spain; in which last place it is cut into vessels and images, because it will bear a very fine polish.

**Bright Red JASPER**, variegated with white, is not so hard as the former, nor of so fine a texture, and is found from the size of a hazle-nut to that of a man's head. The colour is that of red lead, and the most certain colour of the variegation is white, which is almost always disposed in regular narrow veins, though sometimes in spots. That which comes from America is generally accounted best.

**Dull Purple and White JASPER** is of a coarse and irregular, though of a very firm texture. The purple colour sometimes insensibly changes into a pale red, and the white to a yellowish or bluish colour; it is hard to say which of the two is predominant. It is considerably heavy, and so very hard as to be capable of a good polish. It is brought from Italy and Germany, as well as found in England, and serves to make the handles of knives and tops of snuff-boxes.

**Pale Brown Hard JASPER**, with purple veins, has much the same texture as the former, but is more beautiful. It is usually found from two to four inches in diameter, and is commonly of an oblong flattish shape. Its ground is an agreeable pale whitish brown, and its variegations consist of regular horizontal and fine deep purple veins, or of a pretty pure white. It is common in Yorkshire and Suffex, and is sometimes met with in gravel pits near London.

**Yellowish Hard Variegated JASPER** has a very close, hard, and compact texture, though the surface is very rough and irregular. It is generally met with from three to seven inches in diameter, and the predominant colour is a pale dusky yellow, not unlike honey. It is variegated with white, brown, lead colour, and a very pale red, with which is mixed a cloudy crystalline substance. These colours are blended in the form of clouds; but sometimes one and sometimes another is wanting. It is extremely hard, will take a very fine polish, is common in the East Indies, and is also met with in several parts of Europe. The only use of it at present is to make handles for knives.

**The Pale Bluish JASPER**, with black veins and clouds, has a very close firm texture, and its size is from four to six inches in diameter. It is always of a dusky blue or lead colour, and the black clouds appear like curling smoke. It is but of little value, and consequently not much in use.

**The Bluish Marbled JASPER**, variegated with white, is of very little value. The colour is of a pale disagreeable grey, and a pretty clear white; but the former colour is the ground, and the other appears in veins or irregular clouds. It is pretty heavy, hard, and will bear a good polish. It is common in the gravel pits about London, and is generally taken for a bit of blue and white marble that seems to be worn by the collision of other stones, for it is rounded at the edges. There is also a black marbled Jasper, variegated with white, and another marbled with yellow.

**The Hard Dull Flesh-coloured JASPER** is extremely hard, of a very close texture, and is found from eight to eighteen inches in diameter. It is of an extremely pale whitish red or flesh-colour, which

is generally the same throughout, though there are sometimes horizontal veins of a darker red. It is found on the sea shore, and is commonly made use of in pavements. It must be observed, that all these Jaspers strike fire with steel, and will not effervesce with aqua fortis.

**The TURKEY STONE**, called by some the Turquoise, is of two kinds, the oriental and the occidental; the first is rather blue than green, and the other is more inclinable to the latter colour, though it sometimes inclines to a whiteness. They are found in the East Indies, Persia, Spain, Germany and Bohemia. In Persia it adheres to blackish stones, and is very common; but it seldom exceeds the size of a hazle-nut. Those of the East Indies differ in their colour, for such as are said to be of the old rock, always preserve the same colour, but those of the new, are greener. This stone is in so high esteem among the Turks, that those of the better sort are seldom without one; but it is never worn by the women. It is generally valued in proportion to the brightness of the colour. Those that are of the size of a hazle-nut, are of a fine sky blue without any blackish veins; but the lesser sort are not so good. Those that have blackish veins, or are inclinable to greenish, or to the colour of milk, are of no value. There is another Turkey stone, which is nothing but ivory, a tooth, or a bone, which have lain in the neighbourhood of copper ore till they have been tinged with deep blue spots and veins; but when they are put into a gentle fire the colour diffuses itself throughout the whole substance, and becomes of a very fine pale blue. There are several mines of these stones in France; but they may be perfectly counterfeited by art with a tincture of copper in an alkaly.

**The LAPIS LAZULI** is an opaque stone of a sapphire colour, with golden spots or streaks. It differs from an Armenian stone in being harder, for this may be easily reduced into powder; and, besides, it is without veins of gold. This is the stone with which they make the colour called Ultramarine. It is of two kinds, one of which will remain unchanged in the fire, and the other not. It is found in various countries, and the Armenian stone is said to be its matrix, which is met with in gold mines. It is found in very large pieces; but the common sort are only big enough to make knife-handles and the tops of snuff-boxes. The best sort, which will not in the least change its colour in the fire, is brought from the East Indies; and this is the test whether it is right or not; for that in Germany, which is of a middle nature between an Armenian stone and the true Lapis Lazuli, alters in the fire, and is much more brittle than the true. However, they both will serve very well for the use of painters. Lapis Lazuli has the property of purging upwards and downwards, and therefore has been accounted good for melancholy disorders, quartan agues, apoplexies, and the falling sickness. There is no room to doubt that the blue colour arises from particles of copper, for which reason it is taken by some to be a copper ore.

**The ARMENIAN STONE** has a smooth surface, and is of a sky blue colour; but it is brittle, by which it may be distinguished from Lapis Lazuli; besides which it has no gold spangles, nor will it keep its colour in the fire. The blue colour has a greenish cast, and when it is made use of in painting, by length of time it changes to green. It is found in various places in Germany, as in the county of Tyrol, and in other silver mines. It is also met with in Hungary and Transilvania. Whenever it is used as a paint, it must be mixed with petroleum, or rock oil, and then it will keep its colour.

**The ASTROITES, or STAR STONE**, seems to be a kind of opal, and by some is called a Cat's Eye, or Gem of the Sun; but that which is properly so



called has been treated of before. It is a very beautiful stone, and is usually set in rings; it contains the figure of stars so exactly, that no painter can imitate them better. It is an opaque gem, sometimes of a white, ash, dusky, or grey colour. In this sort of stones are sometimes seen roses, sometimes waves, and at other times they contain all three together; which may serve as so many different distinctions of this stone. It is found in various places, particularly in Tyrol, as large as a man's head.

The TOAD STONE seems to be a kind of an astroites; for it is of the colour of that stone, and marked with dark spots, only the ash or grey colour has a reddish cast. It is convex like an eye on one side, and flat on the other. There are two kinds of these stones, the first of which is called by some Brontia and Ombria, and is of a dusky, reddish, yellowish, or greenish colour; sometimes of the size of an egg, and like one, only it is flat on one side. Some take these to be serpent stones or thunderbolts; but the common name is that of a Toad Stone. All these stones differ among themselves: however, that properly so called has the name of Batrachites, but the Brontia and Ombria are called Chelonites. It is now taken to be a petrified substance, and some suppose it to be the tooth of a fish; but this does not seem to agree with its shape. Indeed there may be some in the form of teeth comprehended in this general name; but that resembling an egg is the most common sort. They are all hollow more or less, only some are filled up with the stratum in which they lay, and some of them resemble the cup of an acorn. Another sort are of an oblong figure, but round at the top, and others swell a little in the middle. Many of them have an outward circle of a different colour from the rest, and this is sometimes streaked with very fine lines: some are also found very long in proportion to their breadth, and others perfectly round. They are all naturally of a very fine polish, and are worn in rings without alteration. They are of different sizes, from a pin's head to two or three inches in circumference; and are of a great variety of colours, as above taken notice of.

## CHAP. XXII.

### Of the more ignoble STONES.

**THE EAGLE STONE** seems to consist of several shells or crusts laid one over another; but that which distinguishes it from all others is its being hollow on the inside, in which cavity there is another stone that is smaller: this, when it is shook, may be heard to rattle. It is of various colours, as white, grey, dun, or brown. Modern authors have only three sorts of this stone, the first of which is rough on the outside, and is of different colours, but commonly of a black dun: this makes a very distinct noise when rattled. The second is of an ash colour, and contains a sort of marl in the inside, which is sometimes white, yellow, red, or blue. The outside is rough and sandy, and seems to consist of the particles of flint. A third is of several colours, but has the like contents as the former. The first kind is no bigger than a peach-stone, but the other two are often as large as a man's fist. These sort of stones are found almost every where.

The GEODES is a sort of an Eagle Stone of a round shape, and contains sand or earth, which makes no noise when shook; for when it rattles it may be properly placed in the former class. It is found in Misnia, and near Pelsna in Bohemia. It is of a reddish colour, and of the size of a man's fist; but it is of no manner of use.

The ENORCHUS is another species of an Eagle

stone, and is generally of the size of a pigeon's egg. This contains one stone within another, as the yolk of an egg is contained in the white. It is not smooth on the inside, but is tinged with various dirty colours, and on the outside is of an ash colour.

Authors mention many other species of this Stone, such as the rough purplish, the red and dusky yellow, the yellow, brown, and black crusted, the purplish red, the coarse yellow and brown, and the coarse Eagle Stones.

There are also five kinds of the Geodes, which are distinguished by the names of the Cracked GEODES with ferruginous brown and yellow crusts. This is always hollow, heavy, and of a regular shape; it being oblong, and larger in the middle than at the ends. It is generally about two inches long, an inch and a quarter broad, and three quarters of an inch thick. The outer shell or crust is of a yellow colour, with a mixture of reddish brown, and is smooth to the touch, though it is all over cracked in different directions. However, it is very hard, and will not break without a strong blow; and, when broken, it is found to contain a yellow earth, with a little mixture of sand. It usually consists of three crusts, the innermost of which is of a bluish black colour, the middle of a deep brown, and the outermost yellow as above. It is met with among gravel.

The Wrinkled GEODES, with ferruginous, reddish brown, and gold-coloured crusts, is very heavy when pieces of it are considered apart; but when unbroken it is light, because it consists of a large hollow case. It is about three inches long, and two and a half in diameter, and has no distinct coat different from the general substance. It is of a fine gold colour, with a small mixture of brownish red, and is full of wrinkles or superficial cracks. The cavity is usually divided into several cells, and contains a small quantity of fine bright yellow earth. The shell, when perfect, consists of a great number of coats, some of which are of a ferruginous colour, others of a reddish brown, and others as yellow as gold.

The Sparkling GEODES, with ferruginous, purple, and orange-coloured crusts, is subject to great varieties, excepting the internal structure. However, it is generally oblong and flattish, and sometimes it is full of protuberances, sometimes branched, and sometimes again tapering to one or both ends. It is bred among gravel, and consequently has a very rough outside, it being covered with pebbles of different sizes. It is generally four inches long, two broad, and an inch and a half thick; though sometimes it is twelve inches long. Different stones contain earths of different kinds; and the shell is composed of eight or ten coats, which are all bright and sparkling. Some are of a dark iron grey colour, others of a dusky purple, and others of a saffron or orange colour.

The Long Rough GEODES, with a single purplish crust, is always of an oblong shape, of a firm substance, and considerably heavy and hard. It is yellowish on the outside, and is about four inches long, and three quarters of an inch in diameter; but the surface is strangely rugged and uneven. It has only a single coat of a mixed purplish iron-grey colour, and is a little sparkling.

The Long GEODES, with a single blackish crust, is always of an oblong irregular form, it appearing frequently twisted, and of a different thickness in the different parts of the same mass. The outside is generally so invested with a stratum in which it was formed, as to appear of a brownish yellow. It is sometimes two inches long, three quarters of an inch broad, and above half an inch thick; but it varies in size. It is very brittle, and when broken is of a blackish colour, a little sparkling; and the cavity



cavity is filled with very fine bright red earth, though sometimes it is not without mixture.

The stone called ENHYDRUS is a-kin to the Eagle stone, but it contains nothing but water. The first of these is the thick-shelled Enhydrus with black, reddish brown, and yellow crusts. It is of a close, even, compact texture, pretty heavy, and very hard; and always is of an irregular roundish shape, but very flat, rising in the middle, and thinner towards the edges. It is about four inches in diameter, and two thick where thickest. The surface is rough, and of a mixed yellow and brownish red colour. When broken it is found to be a very thick shell or case, containing a small quantity of water, which is generally muddy. The shell usually consists of three thick coats, of which the innermost is blackish and shining, but that in the middle is of a dusky brownish red, and the outermost of a bright yellow. The cavity is large, and generally divided into different cells.

There are still other stones of the Eagle kind, which may be referred to the Enorchus, of which the first is the very Hard Smooth ENORCHUS, with brown, yellow, and red coats. The texture is fine and compact, with a pretty smooth even surface, and is remarkably heavy. It is always of a roundish oblong figure, and is found from a quarter of an inch to four inches in length; but its usual size is that of a pigeon's egg. It is sometimes met with smooth and glossy, and sometimes covered with a whitish crust. It consists of only five or six coats, inclosing a firm, hard, and solid nucleus of the same nature and texture. This is of a deep dusky brown colour, sometimes of a strong red, and sometimes has a mixture of both. The coats are alternately dark brown and reddish.

The Hard Glittering Rough ENORCHUS, with brown, purple, and deep yellow coats, is much more rugged than the former, and of a coarse unequal texture. It is always of an oblong shape, and is found of several sizes, from half an inch to eight inches long. The surface is made up of small prominences and cavities, less than the heads of the smallest pins, which give it the appearance of flaggreen. The nucleus is but small, and is surrounded with eight or ten coats, irregular in thickness and of several colours, as pale brown, deep brown, dusky and reddish yellow; and the nucleus is sometimes purple, but more generally of an orange colour. The substance is pretty bright and sparkling, not only within, but on the surface of the stone.

The Soft Brownish Yellow ENORCHUS is quite of a different nature from the former two; for this is only a composition of soft earth, though the texture is close and smooth. It is always of a flattish oblong shape, and is commonly four inches in length, two in breadth, and one in thickness. It is of the same colour throughout, and the nucleus is of the same shape as the stone, but of a very agreeable brownish yellow, as well as the coats themselves, which are almost innumerable. It has no manner of brightness, but looks like clay. There are two other sorts of the soft Enorchus, the one with a shining brown and dusky green coat, and the other with a shining whitish, yellowish, and red coat.

The HÆMATITES, or BLOOD-STONE, is so called from its colour, which is that of darkish blood; though it is sometimes black, sometimes yellow, and sometimes of the colour of iron; but its streaks always resemble antimony, and when it is calcined it turns to a reddish colour. It was formerly divided into several kinds, but now there is only one treated of by authors. It is found in various parts of Germany, in marl-pits and iron mines. It is now known to be a rich iron ore; for, when melted, a great deal of that metal may be extracted.

It is of various degrees of purity and hardness; for sometimes it is of a coarse texture, and seems to be composed of large filaments. With regard to its medicinal qualities, it is now generally used in some disorders of the eyes, especially to remove spots and films.

The SMIRIS, in English Emery, may be placed in the class of the Hæmatites. It is of an iron grey colour tending to blackness, and so hard that it is used by jewellers, glass-grinders, and smiths, for polishing their work. It will cut glass almost as well as a diamond, and is reckoned a sort of an iron ore. It is found in large masses, bespangled all over with shining specks.

The PUMICE STONE is spongy and full of small holes and cavities. It is of several colours, as ash-coloured or white, which are so soft that they may be crumbled to pieces between the fingers; but some are more hard, though they are all so light that they will swim on the surface of the water. It is found in divers places, but especially near burning mountains, from whence it is thrown out. It is used by various artists for different purposes; and in some places they use it in the baths to clean the skin.

The MAGNET or LOAD-STONE is well known for its property of attracting iron, and for its polarity; for, when suspended, one end always points to the north, and the other to the south. It is found in various places, and often in iron mines; which is no wonder, for it is a kind of iron ore. It is generally of an iron grey colour, with a bluish cast, and sometimes reddish without, and blackish within; but that which is bluest is best. When a needle is touched with a Load-stone, the Magnet will not attract both ends equally, but will repel the one, and draw the other, which is known almost to every one.

### C H A P. XXIII.

#### OF SAND-STONES, ROCK-STONES, MARBLE and ALABASTER.

THE Bright White Brittle SAND-STONE is coarse, harsh and rough, and of a loose porous texture. The surface is of a dusky, dead white; but immediately after it is broken it glitters pretty much. It is composed of a large angular crystalline grit, which is very hard and firm in the mass; but when in small pieces as soft as loaf-sugar, and falls into a white sand like powder. Water, when poured thereon, will immediately sink through it, though it will strike fire with steel, and will soon blunt the workmens tools. It makes no effervescence with aqua fortis; but it burns to a beautiful pale red. It is used in building, and will bear the weather pretty well; but it will not take a polish. They build houses with it in Northamptonshire without mortar.

The Dull Greyish White Brittle SAND-STONE is coarse, rough, and of a loose texture. It is pretty heavy, without splendor, and is composed of a large irregular grit, mixed with a soft loose substance in the form of powder. When examined with a microscope, it appears to consist of an angular oblong transparent large grit, which adhere together in very few places; but the pores are filled up with a whitish powder, and while in the earth it is very moist and crumbly. It is much used in building, because it cuts very easily. When water is poured thereon it will become wet through; but it will hardly strike fire with steel, and yet it will make a violent effervescence with aqua fortis. It burns to an almost white flesh colour.

The Hard White Dull SAND-STONE consists of



of crystalline grits that are not very pure; but they are cemented together by a finer crystalline substance. It is very coarse and rough, and of a close, compact, dense texture, it being very hard and pretty heavy. It is penetrated by water very slowly, and will not readily strike fire with steel; but it ferments very strongly with aqua fortis, and burns to a pure white. It is common in Dorsetshire, and does not lie so deep in the earth as many others. It is a very good stone for building.

The Loose Dull Whitish SAND-STONE is very coarse and pretty heavy; it is composed of a very hard roundish grit, cemented by an earthy spar. It is not very hard in the mass, and when in small pieces it will crumble into powder between the fingers, and when water is poured on it, it will readily penetrate its surface. It will not strike fire with steel, but will effervesce violently with aqua fortis, and burn to a reddish white. This is known in London by the name of Portland Stone, where it is much used in building. It is so soft while in the earth, that it is usually cut into a proper form on the spot, for afterwards it becomes considerably hard.

The Hard Greyish SAND-STONE is composed of grit of an oblong angular shape, many of which are purely crystalline, and very bright and glittering when viewed through a microscope; but to the naked eye they appear like shining specks scattered here and there. The grits themselves do not at all cohere, but are cemented together by an earthy spar. It will not crumble when broken into small pieces, nor is it at all dusty; likewise water poured on it penetrates its substance very slowly. It will not strike fire with steel, though it is cut with some difficulty; but it will make a violent effervescence with aqua fortis, and burn to a white. This is what is called in London Purbeck Stone, and there are often shells contained therein. It is a good stone for building, but will take no great polish.

The Brittle Brownish White SAND-STONE is very coarse, rough and of a loose texture, being somewhat porous. It consists of a large angular grit, slightly cemented together by an earthy spar; when reduced to small pieces it readily crumbles between the fingers, and sticks to the hands. Water will penetrate it very freely, and therefore it is no wonder it will not strike fire with steel; but it makes a violent effervescence with aqua fortis, and burns to a pale reddish white. It is common in many parts of the kingdom; but it is chiefly brought to London from Portland, where it is much made use of in building, because it will stand the weather, though it cuts very easily.

The Brittle SAND-STONE, with a round grit, is known by the name of the Kettering Stone, though it is not only found about that town in Northamptonshire, but at Ketton in Rutlandshire. It is of a loose texture, and seems to be porous when broken, which is occasioned by the falling out of the inner part of its grit. It is pretty heavy, with but a little brightness, and consists of a roundish grit laid very closely together, as well as cemented by an earthy spar. In small bits it will crumble between the fingers, but not stick to the hand. It will not strike fire with steel, but it ferments violently with aqua fortis, and burns to a pale whitish colour. It is used in many places for building.

The Greenish White Brittle SAND-STONE is coarse and dusty, and its particles cohere so slightly, that they are continually falling off in powder. It is of a loose texture, though moderately heavy, and is full of glittering spangles of talc. The grit is pretty large and angular, cemented by a very loose coarse earthy spar. Water poured thereon will readily penetrate through it, and it cuts very easily. It will not strike fire with steel, but it ferments violently with aqua fortis, and burns to a reddish white. It

is common in all parts of England, and will bear fire better than many harder stones.

Hard Greenish White SAND-STONE is very hard, coarse and rough, though of a firm texture, and is spangled all over with broad glittering flakes of talc. In some places it is variegated with brown spots, and consists of large grit with irregular angles, lodged in a sort of crystalline cement. It is considerably hard in the mass; but small bits may be reduced to powder between the fingers, and it sticks to the hands. It will not strike fire with steel, nor make any great fermentation with aqua fortis. It burns to a pale reddish white, cuts easily, and takes a pretty good polish. It is sometimes brought to London, where it is used in building.

The Brittle Yellowish Brown Glittering SAND-STONE is very coarse, and of a loose texture; but it is considerably heavy, and very full of fragments of talc. It consists of large angular grit, lodged in a dusty cementitious substance, is soft and brittle in the mass, and will crumble between the fingers in small pieces. It will hardly strike fire with steel, and makes but a slight fermentation with aqua fortis. It is used in building, being cheap and easily cut.

The Brittle Pale Brown SAND-STONE is extremely coarse, rugged and rough. It is somewhat spongy and pretty heavy; but it has not so much talc as the former. It consists of oblong grits with obtuse angles, and is cemented by a sort of crystalline substance mixed with earth. It is soft and brittle in the mass, and is easily penetrated by water. It will not strike fire with steel, nor ferment with aqua fortis. It is common in the northern counties, where they make whet-stones of it, which are brought up to London, and much used by shoemakers; it also serves for grinding stones.

The Hard Red Glittering SAND-STONE is coarse and rough, though of a very close firm texture, and will bear a pretty good polish. It is remarkably hard and heavy, and of a deep reddish brown colour, with glittering spangles of talc. It consists of large oblong angular grits cemented with a sparry substance. It cannot be rubbed to pieces between the fingers, nor will water so much as penetrate its surface. It is cut with difficulty, and therefore it is no wonder it strikes fire with steel. It makes but a slight fermentation with aqua fortis, and undergoes little or no change in the fire. This is brought to England in large quantities from Norway.

The Hard Glittering SAND-STONE, of the colour of rusty iron, but sometimes more yellow and sometimes browner, is very beautifully spangled with talc. It consists of a small roundish grit, cemented by a firm deep brown earth, and is remarkably hard even in the smallest pieces, but will not strike fire with steel, though it cuts with great difficulty; nor will it ferment with aqua fortis, though it burns to a deep chocolate colour. It is very plentiful near Bristol, where there are strata twenty feet thick. It stands the weather very well, and is used in some places for building.

The Soft Brittle SAND-STONE, of a brownish rusty colour, is composed of large roundish grit, cemented with a loose ferruginous earth. It is common in most counties of England, and is of little or no use.

The Grey Brittle Dull SAND-STONE consists of large, coarse, obtusely angular grits, cemented by a loose earthy spar. It is very soft and brittle in the mass, and much more so when reduced to small pieces. It will readily split into horizontal plates, and burns to a pale whitish red. It will not readily strike fire with steel, but ferments greatly with aqua fortis. It will not stand the weather very well; being very apt to crumble after hard frosts, though in



some places they cover their houses with it instead of tiles.

The Brownish White Glittering SAND-STONE has a moderately smooth and even texture, and is pretty firm, compact and heavy, but varies in colour on account of the earthy particles that get into the pores of this stone with the water. It is the most bright and glittering of any stone of this kind, and is commonly known by the name of the Flag-stone. It is always found in flat plates from a quarter of an inch to four or five inches thick, and the thinnest of these always lie uppermost. It is considerably hard, and will not break in any direction. It will not easily strike fire with steel; but ferments briskly with aqua fortis, and burns to a greyish white. It is used in the north of England for covering houses instead of tiles; that is, those of the thin sort, for the thicker are employed in paving and building. It consists of grit with blunt angles, cemented with an earthy spar, and interspersed with flakes of bright talc lying in a horizontal direction.

The Greenish Grey Shining SAND-STONE is of a hard, coarse, rough and somewhat spongy texture; but is considerably heavy, and full of bright glittering spangles. It consists of large angular grit that lie very close together, among which are dispersed great numbers of fine small very bright flakes of talc, which, with the grit, are cemented with a small quantity of a very pure transparent substance. It will readily split in a horizontal direction, but not into very thin flakes. It does not readily strike fire with steel, and makes but a slight fermentation with aqua fortis. It is used in some places for covering of houses.

The Yellowish Grey Glittering SAND-STONE somewhat resembles the former; but is very rough, coarse and harsh, and considerably heavy. It is met with in many parts of France.

The Hard Purple and White Laminated SAND-STONE is the hardest and most elegant of this class, though very rough and harsh. It is of a very close texture, extremely heavy, and the colour is finely variegated with greyish white and purple. The plates or flakes are much thicker than many of the former, and is extremely bright and glittering, on account of the large quantity of talc contained therein. It splits very easily, and is composed of fine glittering grit, cemented with a pure shining substance. It is extremely hard, and consequently will strike fire with steel; but it will not ferment with aqua fortis. It is common in Italy, where it is used for pavements.

The Bluish Glittering SLATE STONE is pretty fine and smooth, and of a close compact texture. It is extremely heavy, and full of talky particles, and more easily cleaves into plates than any of the former, which are generally about one tenth of an inch thick. It consists of small irregular sharp grit, that is often entirely blended with the cement, which is of the same crystalline substance with itself, though debased by a mixture of earthy particles. It is extremely hard, strikes fire with steel, and ferments slightly with aqua fortis. This stone is common in Italy.

The Dense Dull Whitish ROCK-STONE is moderately fine, but of a very irregular texture. It is composed of a soft whitish earthy spar, intersected with flat plates of the crystalline sort. The earthy part of this stone is pretty dense, but not so hard as the crystalline, and there is no grit of any kind. It ferments greatly with aqua fortis, and burns to a bluish white, mixed with a little red. This is very common in many counties, and is brought to London from different places, where it is used in building.

The Hard Greyish White Dull ROCK-STONE

is of a compact texture, with a smooth surface, and is considerably heavy. It is composed of no visible grit, and is easily cut; it will not readily strike fire with steel, but ferments violently with aqua fortis. It is common in several counties of England, is used in buildings, and stands the weather pretty well: some burn it into a poor coarse sort of lime.

The Hard Porous ROCK-STONE is of a coarse spongy texture, and yet very hard and heavy. It is generally of a greyish white, though sometimes brownish, yellowish or black, from the different kinds of earthy particles falling into it with the rain. It has no grit, and is very hard, even so much as to spoil the workmens tools. It strikes fire with steel, but will not ferment with aqua fortis. It is common in Yorkshire, where the strata lie very deep. It is used for building in that county.

The Hard Bright Grey ROCK-STONE is more like crystal to the naked eye than the former, and consists altogether of a sparry substance. It is a very elegant beautiful stone, for it is bright, shining, and very heavy. It will hardly strike fire with steel, but ferments violently with aqua fortis, and burns to a pale bluish red. It is not very common; but there is some of it in Yorkshire, where they both use it for building and for burning into lime.

The Hard Bright Brownish White ROCK-STONE is very heavy, and of a close texture, consisting of a crystalline spar, which in thin plates is a little transparent. It will not strike fire with steel; but ferments very briskly with aqua fortis, and burns to a pale whitish red. It is brought from Purbeck to London, where it is used for building and pavements. It is also used in Northamptonshire for building and making tomb-stones.

The Dull Yellowish White Hard ROCK-STONE has a close firm texture, with an irregular surface, and is very heavy. It is of a pale dull white, with pale yellow veins and spots in several places; but it is not bright, though composed of crystalline spar. It will not easily strike fire with steel, but ferments violently with aqua fortis, and burns to a white colour. It is common in Dorsetshire, and sometimes contains shells. It is very useful in building, because it wears the weather very well.

The Dull Hard Brownish White ROCK-STONE generally consists of above half shells, and is a very coarse harsh stone without any brightness. It will not readily strike fire with steel, but ferments violently with aqua fortis, and burns to a greyish white. It is brought in great quantities from Purbeck to London, where it is used for flat pavements.

The Whitish Grey Marble ROCK-STONE is considerably fine, remarkably heavy, and of a fine firm texture. It has a somewhat sparkling appearance, and is entirely without shells. It is considerably hard, and will bear a pretty good polish; it strikes fire with steel, but will not ferment with aqua fortis. It is found in the Eastern countries, as well as Italy, and some parts of Germany.

The Yellowish White Flinty ROCK-STONE is very fine, smooth and glossy, and its texture is pretty much like that of common flint. It will hardly strike fire with steel, but makes a very great and lasting fermentation with aqua fortis, and burns to a greyish or bluish white. It is common in some parts of England, and is known by the name of the Rag-stone and Lime-stone. It is generally free from clefts; but when there are any, the sides are always covered with a crystalline spar. It is used in the pavements of streets.

The Brownish White Flinty ROCK-STONE is in some parts of England called Chert or Wern, has a very compact firm texture, and is considerably heavy. It has sometimes veins and spots of red, white or black. It breaks with an even glossy surface, like that of flinty pebbles: and strikes fire with



with steel, but makes no fermentation with aqua fortis. It is often found among other strata of stone, and Dr. Woodward mentions one of three feet thick in Yorkshire.

The Bluish Flinty ROCK-STONE is very soft and smooth, with a close even texture, and is considerably heavy and hard. It has sometimes bluish white veins, and is found in most counties of England. It strikes fire with steel with some difficulty, and makes a strong and lasting fermentation with aqua fortis. In some places it is burnt into lime, which is very good.

The Hard Bluish ROCK-STONE is very rough, and is generally full of shells or spar. Its texture is firm, and is extremely heavy; it will not readily strike fire with steel, but ferments violently with aqua fortis, and burns to a pale whitish grey. It is brought from Purbeck to London, where it is used in pavements. It is hard to cut, and therefore not much used in building.

The Brownish Blue Dull Hard ROCK-STONE is coarse and rough, and pretty heavy. It is generally variegated with lines and spots of a pale red and of an opaque white. It will not strike fire with steel, but makes a strong and lasting fermentation with aqua fortis, and burns to a pale bluish white. It is called in Leicestershire the Blue Lime-stone, for it makes good lime.

The Dull Pale Red ROCK-STONE is pretty fine and smooth, of a firm texture, and considerably heavy. It is variegated in most places with lines and spots of a pale red, or of an opaque white. It will not readily strike fire with steel, but ferments violently with aqua fortis, and burns to a very pale whitish or greyish red. It is used for building walls in some places, and is also burnt to lime.

The Hard Shining Red ROCK-STONE is very heavy, and is spangled in many places with small bits of a very glossy spar. It is extremely hard, and will take a good polish; it will not readily strike fire with steel, but ferments violently with aqua fortis, and burns to a pale red. It is imported from Sweden, Norway and Denmark, and is used in pavements; it is also to be met with in Yorkshire. That of Norway contains fine straight shells, but that in England is without them.

The Green and Red Variegated ROCK-STONE has a rude irregular structure, and is but coarse for one of this class. However, it is not porous, is pretty heavy, and interspersed with blotches and soft uneven lines of a fine paler green spar, as well as a few fragments of a white and semi-transparent one. It is found in the lead mines of Derbyshire; but is of no use.

The Hard Black Dull ROCK-STONE has a close firm texture with a smooth surface, is pretty heavy, and extremely hard; but has no gloss, except a few shining specks in some places. It is not unlike black marble, but will not readily strike fire with steel: it ferments violently with aqua fortis, and burns to a fine bluish white. In Leicestershire it is burnt into lime.

The Hard Black Shining ROCK-STONE is somewhat coarse, but extremely hard, very glittering, and remarkably heavy. It does not ferment with aqua fortis, and burns to a pale brownish red. It is found in Derbyshire, but is hitherto of no use.

The Soft Dull Black ROCK-STONE has a pretty smooth surface, but no very firm texture, and though very heavy, has not the least brightness. It has somewhat the appearance of slate, though it will not cleave; nor will it strike fire with steel, nor yet ferment with aqua fortis. This is known every where by the name of Rag-Stone, and is more properly so called than the yellowish white one before mentioned, because when broken it has a ragged appearance. This is used as a whetstone all over England, for common knives and carpenters tools.

## CHAP. XXIV.

## OF SLATES.

THE Brittle White SLATE-STONE has a pretty close texture, and is considerably heavy, though dull. It consists of various plates from one sixth of an inch to an inch thick, and will split pretty easily. It will not strike fire with steel, and ferments strongly with aqua fortis. It is very common in England, and particularly in Northamptonshire, where it lies near the surface of the ground. It is made use of to cover houses.

The Purple SLATE is a fine beautiful kind, and is pretty heavy. It is firm and compact, and the colour is a fine pale purple, glittering all over with small glossy spangles which are very bright, and so minute that they are not to be seen distinctly without a careful examination. It consists of very thin plates or flakes laid evenly upon each other. It will not strike fire with steel, nor ferment with aqua fortis; but is greatly valued as a covering for houses in the northern counties of England, where it is found.

The Common Blue SLATE is almost universally known, and is a very useful stone. The texture is fine and smooth, and consists of even plates laid close upon each other, which will readily split. It will not strike fire with steel, nor ferment with aqua fortis. It is used almost all over England for covering of houses, and is much better than tiles.

The Brownish Blue Brittle COAL-SLATE, which is always to be met with in coal-pits, is of no manner of use.

The Greyish Black Brittle SLATE, by some called Shiver, is of a very loose open texture, though pretty heavy: but the structure is regularly plated, and the plates seldom cohere to each other. It is very soft, and is readily penetrated by water. It will not ferment with aqua fortis, and burns to a faint red. It is common in the northern counties of England, and is made use of for manuring land, in the same manner as marl.

The Greyish Blue Sparkling SLATE has a very compact texture, but somewhat uneven, and consists of irregular plates, which will split into those that are very thin. When large masses are found, they are often bent and undulated, and towards the upper part of the stratum are frequently observed to be defective. They are composed of regular oblong fibres, which are all very bright and glittering when the mass is just broken, having somewhat of the appearance of talc. It will not strike fire with steel, nor ferment with aqua fortis; but burns to a yellow spangled mass. There are large strata of this in some of the counties of England, and is sometimes found on the sea shore. It is often used as a whetstone to give a good edge to tools.

The Irish SLATE is the most soft and brittle of all this class, it being coarse, rough, and of a crumbly texture; but is pretty heavy, and of a brownish black. It consists of a multitude of thin plates laid evenly upon each other, and splits very easily. It will not strike fire with steel, nor ferment with aqua fortis; but will burn to a strong bright red. It is somewhat of the nature of alum, and is very common in Ireland; it is also found in Somersetshire and other parts of England, where it always lies near the surface of the ground in a very thick stratum. It is used in medicine against bruises, and is given by some from one drachm to two in curing quartan agues; but its principal use is for internal bleedings.

At Isleb, in the county of Mansfield, there is found a black Slate, which has the images of various fishes of a black or yellow colour; and they appear to be so finely done, that the very scales may be seen.



C H A P. XXV.  
Of M A R B L E S.

**T**HE PARIAN MARBLE is so called because it was brought from the island of Paros. It is of a white colour, extremely hard, and takes a very fine polish. It has a firm, compact, close texture, and is considerably heavy; its extraordinary whiteness has sometimes a bluish cast, with blue streaks of different breadths. It is not very hard to cut, and therefore is in great esteem among the statuaries. It consists of pretty large particles with flat surfaces, but much smaller and more regular in their size and shape than those of the alabaster kind. It will not strike fire with steel, but ferments violently with aqua fortis, and when burnt is almost as white as snow. Some say this marble receives its name from Agoracritus Parius, who first carved a statue of Venus out of it.

The Hard White MARBLE, called Carrara by the moderns, is whiter than the Parian, but is not of so great value, because it is more hard to cut, and will not take a fine polish; however, it is used for building, as well as to make statues. It has a more firm and close texture than the former, and is very heavy; besides, it has greater transparency than any other white marble. It consists of small glittering particles, many of which appear to have flat surfaces, and consequently lie close together; and it is supposed to consist of a perfectly white spar. It will not strike fire with steel, but ferments violently with aqua fortis, and burns to a pure white. This marble is found in Italy, from which country large quantities are brought to England.

The Hard Pale Yellow Glossy MARBLE is of the same colour throughout, and is considerably heavy, with a close firm texture. It is very fine and smooth, and between the colour of honey and Venice turpentine. It will readily break in any direction into a smooth glossy surface. It will not strike fire with steel, nor ferment greatly with aqua fortis; but burns to a fine pale red.

The Numidian MARBLE of the ancients is hard, shining, of a bluish colour, and is very remarkable for its hardness. It will bear an extremely fine polish, on account of its compact even texture. It is not at all transparent, unless in very thin pieces. It will not strike fire with steel, but ferments greatly with aqua fortis, and burns to a pure white. It is found in Italy, Spain, France and Germany, and is a fine strong, durable marble, though not in great esteem.

The Black Namur MARBLE is very fine and smooth, having a close firm texture, and is very heavy. It is full of fine small glossy particles, which look like so many spangles. It will not strike fire with steel, but ferments violently with aqua fortis, and burns to a pure white. It is a useful marble, though not much esteemed.

The Chian MARBLE is of a black colour, and very fine and hard. It is used in England, as well as in other places, for a touch-stone; and is in great esteem with the goldsmiths for that use, it being the best of this kind. It is perfectly smooth when broken, but is very dull, and does not shine at all. It appears to be one pure, unmixed mass; and cuts with difficulty, but very smoothly. It will not strike fire with steel, but ferments very strongly with aqua fortis, and calcines to a pure white. It was formerly brought from the Island of Chios; but we have it now from Italy. It is capable of a very high polish, inasmuch that it has been used instead of a mirror.

The Lydian STONE of the ancients is a hard black Marble, in the shape of columns, and is called Basaltes by Boet. It is reckoned among the Marbles

by Pliny; and indeed it is the hardest of this kind, for a file will not touch it. It is also called Basanus, from a Greek word that signifies to examine, because this was the touch-stone of the ancients. It is now met with in various parts of Germany, and particularly in Silesia; but the greatest quantity of it known is the Giants Causeway in Ireland, which appears so regular that it was at first taken to be a work of art. This Marble is of a very fine, smooth, even texture, and is of so glossy a black that it resembles high-polished steel, without any foreign matter. It is always found in one smooth homogeneous mass, but not in quarries like other Marbles; for it always stands upright in regular columns, consisting of a great many joints, one of which is exactly placed and fitted to the other. A vast number of these are so regularly put together, and joined by their sides, that they seem to have been placed so by a very skilful workman. Many of these columns make large pillars, some of which are at small distances from each other. The single columns are all angular, and consist of from four to seven angles; but the first are most uncommon. It will not strike fire with steel, which must be on account of its smoothness, for it is certainly hard enough for that purpose; likewise it makes little or no fermentation with aqua fortis. This stone may be made use of on various occasions, and is well known to make the very best kind of burnishers for polishing silver.

The Lacedemonian MARBLE of the ancients is of the green kind, and is taken notice of by Pliny. It is different from the Ophites, because that is variegated with spots like serpents, from whence it took its name, for that word signifies a serpent; besides, the columns that are made with this last are always very small. There is also another of this kind, of a dark green, which is finely painted with crosses of a lighter colour, which are so fine that common spectators would take them for the effect of art. This Marble has a close compact texture, and is very hard and heavy. It is of a fine bright green, and takes a very good polish. It will not strike fire with steel, but ferments violently with aqua fortis, and burns to a pure white. It was first brought from Lacedemonia, afterwards from Egypt, and is now found in Germany, Sweden, and England. There is said to be a stratum of it near Bristol, and many in Wales, where it may be had in any quantity.

The Derbyshire MARBLE is of a whitish brown colour, and has a fine close texture. It will not strike fire with steel, but ferments violently with aqua fortis, and burns to a pure white. It is so full of marine substances, that four fifths of the whole mass seem to be composed thereof; it is particularly full of entrochi, which are a sort of shell of an oblong round form, furrowed on the outside, as if it was divided into joints, marked with a star at the end, which are supposed to be part of the Star Fish; but this is uncertain. They are of all sizes, from the thickness of a large pin, to half an inch or more. They will take a very elegant polish in the mass, and are much used for chimney-pieces, tables, and the like. It is found in vast quantities in Derbyshire, and some will not allow it to be Marble, but call it the Derbyshire Stone.

The Green MARBLE, thick set with small sea shells, is of a very beautiful kind, and will bear a very fine polish. It is of a delightful bright green; but does not sparkle. The roundish black lines, and pale brownish white specks that are found in it, are thought to be small sea shells, filled up with an impure white earthy opaque spar; but, be that as it will, it is a very elegant curious Marble. It ferments violently with aqua fortis, and calcines to a pure white. There are very large quarries of it in Germany, Bohemia, and some parts of France, where



where it is used in the ornamental parts of buildings.

The Greyish Green MARBLE, thinly set with shells, is somewhat coarse and rough, and of an irregular and pretty firm texture, moderately heavy, and considerably hard. It is of a dull dusky greyish green colour, and will ferment violently with aqua fortis. It is found in Derbyshire, Dorsetshire, and Essex.

The Hard Greyish Black CORALLOIDE MARBLE, has a very fine smooth even texture, and is considerably bright and sparkling; but does not seem to consist of a homogeneous mass when broken, but of many closely compacted particles. It abounds with a sort of coral called Porus, set at small distances and in all directions: they are generally about an inch and a half long, and three quarters of an inch broad, and are composed of longitudinal plates, which are very fine, thin, and of a snow white colour. In the most perfect specimens there are processes like wings, of a close irregular net-like texture, expanded on each side near the top, and of this sort of texture the whole body is full; the interstices are filled up with a greyish white spar, and form a very beautiful figure. It is found in great plenty in Derbyshire, and according to Dr. Woodward in Wales. The tomb of Sir Thomas Gresham in Great St. Helen's church is built with it.

The Black CORALLOIDE, marbled with shells, is of a very close, firm, even texture, and is very hard and pretty heavy; it will bear a very fine polish. It is variegated with a Coralloide Porus not unlike the former, but smaller. There are also great numbers of large sea shells of the turbinated and bivalved kinds, lodged in various directions, and of a clear bright white. The cavity of the porus and shells are all filled up with the black substance of the marble; but they retain their shape in a very perfect manner. It ferments violently with aqua fortis, and is common in Ireland, from whence it is brought to London.

The Purple and White Variegated MARBLE is generally pretty fine, with white veins, spotted and variegated with purple. In some blocks the purple makes the ground, and the veins and spots are white; there are also blotches of other colours, as pale red, pale brown, yellowish, greenish, and yellowish brown. The different substances, which compose this Marble, are generally distinct masses, particularly those of the purple and white kind. The whitest is most pure, and therefore is hardest, brightest, and most transparent. The pale red is next, the purple next to that; but the brownish, greenish, and yellowish, are very earthy, and almost perfectly opaque. There are silvery particles in this Marble, which are supposed to be a very pure spar. This is a common Marble in Italy, and great quantities of it are brought to England.

The Brown and White Brittle MARBLE is the softest of this class, and has a pretty coarse texture; but it is considerably heavy, and of a pure snow white, finely variegated with slender lines, and veins of a deep brown earthy colour, and in some places there is a faint cast of pale red: when broken, glittering particles appear as in the former, which are disposed in small flakes. The white parts or ground are extremely like the finest loaf-sugar, and is so soft that it may be cut with a knife. Water will readily soak through it, and it makes a violent effervescence with aqua fortis. It is common in Italy, and serves to make chimney-pieces.

Hard Variegated Red and White MARBLE is very fine, remarkably heavy, and is somewhat of a bluish ground, finely variegated with red, brown, and yellow veins. It is very glittering in many parts, and will take a very fine polish. It will not strike fire with steel, nor ferment greatly with aqua

fortis. It is a beautiful Marble, and is found in great plenty in Devonshire, from whence it is sent to London.

The Blue and White Variegated MARBLE has a large rough grain, is moderately heavy, and is of a bluish white, or of a fine bright pearl colour, variegated with broad veins of a dusky blue, which often make up the greatest part of the Marble. The white parts when broken appear bright and sparkling, but their texture is loose. The blue is of a smooth texture, and extremely dull. It is moderately hard, and takes a very good polish. It ferments violently with aqua fortis, and burns to a greyish white. It is common in Italy, from whence large quantities are brought to England, where it is used for monuments.

The Pale Brown MARBLE, with white and red veins, has great variations, both with regard to the ground and the veins. The texture is pretty fine, close and smooth, and is considerably heavy. The veins are sometimes of a bluish white, without any other mixture, and in some they are only red. The red is of all degrees, from the brightest colour to the purple of porphyry. It is considerably hard, and takes a very beautiful polish. It ferments violently with aqua fortis, especially in the red and white veins. It is a common English Marble, and there is great plenty of it in Cornwall, Devonshire, and Wales. It is used in London for tables.

The Brown MARBLE variegated with white and black is pretty fine and smooth, though subject to cracks and flaws. It is moderately heavy, and the brown colour is variegated with very beautiful whitish and black branded veins of various figures: sometimes it is difficult to determine whether the white or brown is the ground. The brown is of different degrees of colour, and is disposed in a very odd manner; for it sometimes, when black, seems to resemble rocks, clouds, rivers and landscapes. It is common in many parts of Italy, where it is in good esteem for ornamental works.

The Hard Brown MARBLE, variegated with white, and is the hardest of this class, is remarkably heavy. It generally consists of only two colours, yellowish brown, and a dusky white; but they are in many different proportions, and the veins are composed of very different shades, which generally resemble the windings of rivers, and seldom any thing else. It ferments but little with aqua fortis, nor will it readily calcine; it is very hard to work, therefore is not much in use; it is found in Italy, but not very common.

The Yellow and Purple Variegated MARBLE is a very curious kind, and the ground is of a beautiful pale yellow, with fine purple veins; there are others that are dark brownish, blackish and white. The structure is smooth and even, and it will bear a very elegant polish. It will ferment somewhat briskly with aqua fortis; and when calcined turns to a beautiful pale red. It is found in Italy, and with us bears a very great price.

The Blue and Yellow Variegated MARBLE would be very valuable, if it would admit of a fine polish; but, as it does not, it is not in great esteem. The ground, which is coarse, is of a deep yellow, mixed with a fine blue; which in some places is so deep as to be almost black, and in other places so light that it looks like a pale grey. Its texture is loose and open, and it is common in Spain, Italy, and Africa.

The Black MARBLE, with white veins, has a very firm texture, and is of a fine deep black, variegated with narrow white veins, running generally straight and even. It is pretty hard, and will bear a good polish, and when broken one way it is very bright and sparkling. It ferments but little with aqua fortis, and calcines to a dusky grey: it is com-



mon in Italy, and is used with us for chimneys and tables.

The Bluish Black Hard MARBLE, with snow-white veins, has a somewhat rough and harsh texture; but is considerably hard, and will bear an excellent polish. It is somewhat bright and glittering when broken in the black part, and the white veins glitter greatly. It ferments violently with aqua fortis, and when calcined is of a mixed grey. It is common in Italy, and is brought to us from Leghorn.

The Black and Yellow Variegated MARBLE has a very fine close texture, and is very heavy. The black is deep, and variegated with a great number of yellow veins. It will bear a very fine polish, and then the yellow veins look like gold; but when there is any white, they appear like silver. There are great quantities of this Marble brought from Italy, because it is of very great use with us, and highly esteemed.

The Black MARBLE, with white and red veins, is of an irregular but close texture, and is considerably heavy. The ground is black, and sometimes inclines to blue, and the variegations are chiefly of a clear bright white; but there are some of a beautiful red. Sometimes the white part is so great, that it is hard to determine whether the white or black is the ground. The red veins commonly appear of a granulated structure, and the whole is very hard, and will bear a very fine polish. It will not strike fire with steel, but ferments pretty briskly with aqua fortis, and burns to a mixed grey. There is a great deal of this Marble in Ireland, from whence it is sometimes brought, though very rarely.

The Black MARBLE, with red, white and yellow veins, is pretty coarse and rough, though of a firm texture. The ground is of a deep black, which is beautifully variegated with all degrees of red, yellow and white, dispersed in irregular veins. It is brightest in the white part, and the red and black sparkle, though very little; but in the red it is scarcely perceivable. It takes a pretty good polish, and ferments though but little with aqua fortis, except in the white veins.

The Green MARBLE, variegated with white veins, was in much esteem with the antient Romans. It has a firm compact texture, is remarkably heavy, and green and white are of such different degrees, that they make a very agreeable variegation. Besides these, there are spots and veins of a blackish colour, and the whole is so hard that it will bear a pretty good polish. It ferments briskly with aqua fortis, except where it is green and flaky; and is brought from Egypt and other places.

The Greenish Black and White Spotted MARBLE is the black Ophites or Serpent-Stone of the antients. It was so called because it had spots in the form of serpents; for the name was owing to the figure of the spots and lines, and not of the stone itself. It is a very beautiful and pretty hard marble, of a firm texture, and remarkably heavy; the ground is a very fine green, variegated with small black spots and irregular lines, and sometimes with those that are white. They are sometimes pretty large, and half blended with the general substance of the mass, and sometimes there is the blush of purple throughout the whole. It ferments violently with aqua fortis, and burns to a mottled grey. This marble is now found in various parts of the world, and particularly in the islands of the Archipelago; there is also a sort of it in Wales, which is known by the name of the Anglesea Marble.

The Greenish Soft MARBLE, variegated with white and black veins and spots, is the white Ophites of the antients. It is of a pretty fine smooth texture, moderately heavy, and when pure, of a very elegant pale green, with spots, clouds and lines of a

fine deep black and whitish green, which is sometimes entirely white. It is soft and easily cut, but looks very bright when wrought. It ferments violently with aqua fortis, and burns to a dusky grey. It is found in France, Italy, and Germany.

The Ash-coloured MARBLE with small black spots, is the Tephria and grey Ophites of the antients. It is a fine smooth marble, pretty firm and compact, and considerably heavy. The ash colour is lively and beautiful, the black spots of irregular figures, and the sixth part of an inch in length. It is pretty hard, and takes a fine polish. There is a great deal of this in Germany, but it is not so good as that of the antients, which is brought from Ethiopia and Egypt.

The Greyish Brown MARBLE, with bright green spots, has an even texture, is considerably firm, and very heavy. The spots are small, generally of an oblong figure, and will take a very fine polish. The green parts especially ferment greatly with aqua fortis, and burn to a pale mottled grey. It is common in Egypt and Arabia, and is said to be met with in England.

The pale grey MARBLE, with green spots and veins, is extremely firm and very heavy, and in some places slightly tinged with a very faint red, and in others with a colour that is nearly white. It is variegated with a very beautiful pale green, consisting of small oblong irregular spots, and sometimes of narrow uneven veins. It is very heavy, and will bear a beautiful polish. It is common in Germany, and Dr. Woodward takes notice of a specimen found on the sea shore in Cornwall.

The Red MARBLE, with white and gold veins, is the Theban marble of the antients. It is a very beautiful marble, and of a very smooth regular texture. The red is variegated in some places only with white, and in others only with yellow or gold colour; these are very large and broad in some places, and very narrow in others, for they generally make up almost half the mass. It is found in Egypt, Italy, Germany and England; but the Egyptian is the finest, and the English the worst.

## C H A P. XXVI.

### OF ALABASTER, PORPHYRY and GRANITE.

THE Snow-white Shining ALABASTER is that called the Lygdine by the antients. It is not very compact; but is heavy, and consists of a multitude of broad, flat, large particles, which are very bright and perfectly white. It cuts very freely, and is capable of a fine polish. There are very large strata of it in Arabia, Egypt, and many parts of Italy; but it is seldom brought over to England.

Whitish Yellow ALABASTER, of a soft consistence, is of a loose open texture, considerably heavy, and nearly of the colour of honey; but the colour is more deep in some places than others. It consists of irregular pieces that lie in tables one over another, though with regularity; however, they all together compose a remarkably bright mass, which is very brittle. It is found in Cappadocia, and has been met with in Germany and France, as well as in Derbyshire.

Yellowish and Reddish Variegated ALABASTER is the common Alabaster of the antients. It is so soft that it may be cut with a knife, and has the same name in all languages. It is remarkably bright, glittering and almost transparent, and its texture is very loose and open, though it is moderately heavy. The ground is of a fine clear pale yellow, between that of honey and amber, and has the same texture as the former; but is beautifully variegated with crooked undulated veins, some of which are broad, and



and others narrow; some of a pale red, others whitish; and others again of a very agreeable pale brown. It will bear a very fine polish, and consists of large angular sparry concretions. It is not proof against water, ferments violently with aqua fortis, and burns to a pale grey colour. It was formerly found in Egypt, and is now met with in many parts of England.

Purple PORPHYRY, with pale red and white spots, is the Porphyry of the antients; by whom it was placed among the red marbles, of which it was reckoned the chief, on account of its hardness and splendor. It is named Porfido by the Italians, and there are two columns of it before the gates of St. John Baptist, in Florence. The texture is not so fine as many of the common marbles, and it always breaks with a rough irregular surface; but is remarkably firm, compact and heavy, and of a fine deep purple variegated more or less with pale red and white spots, as also a few flaky black spots. The purple is of all degrees, from the colour of claret to that of a violet, and the variegations are generally distinct spots of various sizes. It approaches the nearest to the hardness of a gem, and was always in very high esteem. It is found in great plenty in Egypt, which was always famous for this stone; but now it is met with in other places, at least with variations. They will all strike fire with steel, but will not ferment with aqua fortis. This is frequently made use of as a stone for grinding colours.

The PORPHYRY of the colour of red lead, variegated with black, white and green, has the hardness and all the other characters of purple Porphyry; but it excels it in brightness, and in the beautiful variegations of the colours. The texture is harsh, rough and irregular, but it is remarkably heavy. The ground is of a bright red lead colour, and in various degrees. It has very regular green veins, and some that are perfectly white, with a great number of small black specks; but these are never mixed with the green, that make a considerable part of the whole. It takes an exceeding fine polish, strikes fire with steel, and will not ferment with aqua fortis. It is found in the island of Minorca, and this might serve for many valuable purposes, if it was imported into England.

The Pale Red PORPHYRY, variegated with black, white, and green, is of a very compact firm texture, considerably heavy, and of a pale flesh colour, often approaching to white. The variegations are in large blotches from half an inch to an inch broad, and now and then disposed in irregular veins. The surface is bright but does not glitter, and its extreme hardness renders it capable of a very high polish. The red, white and green parts appear to be all tabulated, and the green has a tinge like that of gems, and is the brightest of all, it being nearly transparent. It is found in Arabia Petraea, and in Upper Egypt. There are also small pieces of it in Germany and Ireland, and they have been sometimes seen in Devonshire on the sea shore.

The Hard White GRANITE, with black spots, called in Cornwall Moor-Stone, is of a large and gross texture, and appears to be a rude, but beautiful mass of variously constructed and differently coloured particles, distinct from each other, though they cohere very strongly. It is considerably hard, and mottled with black and white, among which there are perfectly transparent particles that are very bright; there are great numbers perfectly black, and others of the colour of brown crystal: some of these intersect, and are divided by other granulae; but others lie parallel with, and others evenly upon them; and others again are quite buried in the substance of the crystalline particles, like flies in amber. Some again are single and thin plates, and others large and broad laid singly on each other.

The whole is extremely bright and glittering, and will take a pretty good polish. It strikes fire with steel, but will not ferment with aqua fortis, and undergoes little change in the fire. There are vast quantities of this in some parts of Ireland, as well as in Cornwall and Devonshire, where it is found in exceeding large masses on the surface of the ground. It is used in London for the steps of publick buildings.

The exceeding Hard Red GRANITE, variegated with white and black, is the Syenites of Pliny, and the Oriental Granite of the moderns. It is called by the Italians Granito Rosso, and of this the obelisks are generally made in Egypt. Travellers tell us of an obelisk, in Alexandria, made of one solid block of this Marble, which measures eighty feet in height. The texture of this Granite is coarse, harsh and rough, but extremely heavy. It is of a very beautiful pale red, variegated with white and black. All parts of it are bright and glittering, being capable of a very fine polish. It strikes fire with steel, but will not ferment with aqua fortis.

The Pale Whitish GRANITE, variegated with black and yellow, is found in the island of Minorca, where there are vast quantities of it. It is often found on the shores of the island of Guernsey, and is used for pavements in the streets of London.

## CHAP. XXVII.

### Of Common Circumscribed STONES.

**T**HE Brown STONE, grey on the outside and divided by partitions, has a very firm compact even texture, with a smooth surface. It is of various sizes, but generally between six and twelve inches in diameter. They are not always of the same shape, but are most commonly roundish, or inclining thereto. They have always a multitude of fine flaws like those of common flints; which chiefly appear upon breaking them; and they always break in these flaws, which are lined on both sides with an extremely thick crust of grey clay. Besides these narrow cracks, there were originally others, which are now filled up with a pure spar of a pale yellowish white, and pretty transparent. These are always thickest in the centre of the stone, and become thinner and narrower as they approach the surface. The stony matter of this kind is considerably heavy, moderately hard, and will bear a slight polish. It will not strike fire with steel; but ferments violently with aqua fortis, and turns to a whiter colour in the fire; the matter, which divides the several parts, burns to a pure white. It is very common in England, and sometimes contains shells, besides a beautiful delineation of shrubs, plants, and mosses.

The Hard Brown STONE, with few divisions, has not a grey crust like the former, but the colour within is nearly the same. The texture is firm, but the surface rough and irregular; and the usual size is from four to twelve inches in diameter. The shape is different, but it has always somewhat of an oval; and when broken there are small shining sparry specks. The divisions or septa are very few, which appear in the form of shining veins; and there are some that have none at all. It will not strike fire with steel, but ferments greatly with aqua fortis, and calcines to a greyish white. It is common in the clay pits between London and Islington.

The Hard Blackish Brown STONE, with whitish partitions, is coarser than the former; but the texture is firm, and it breaks with a rugged uneven surface. It is seldom above six or eight inches in diameter, and often no bigger than a hen's egg, but the



the shape is nearly round. It is always covered with a pale brown crust, about the third of an inch thick, where it is softer than within. The divisions are very numerous, and always filled up with a whitish spar. The inside of the stone is, of a dusky brown, with irregular variegations of black. It is considerably heavy, and will take a pretty good polish. It will not strike fire with steel, but ferments with aqua fortis, and burns to a pale reddish white. It is found in most parts of England, and is common near London.

The Hard Brownish Yellow STONE, with yellowish white partitions, is very firm and hard, with a smooth compact texture. When broken it has a smooth flinty surface, is of various sizes from four to twelve inches in diameter, and generally roundish with somewhat of flatness. It is covered with a deep yellow crust, softer than the substance of the Stone, which will crack when exposed for some time to the air. This Stone is very hard, heavy, and will bear a tolerable polish.

The Hard Greyish Brown STONE, with brown partitions, is very close and compact, and has a very smooth surface when broken. It is met with from three to four feet in diameter, and the shape is always irregular. It is without a crust, and sometimes appears a little bright. The veins, which are few, are very broad; and, though it is remarkably hard, it will not strike fire with steel, but ferments violently with aqua fortis, and calcines to a greyish white. It is common about London and elsewhere.

The Hard Ferruginous Brown STONE, with brown partitions, is very firm, strong, and of a compact regular texture, with a smooth even surface when broken. It is two or three feet in diameter, is generally broad and flat, and most commonly without a crust. It breaks into thin flakes in a very regular manner, with a great many shining specks. It is remarkably heavy, very hard, and will bear a pretty good polish. It will not strike fire with steel, but ferments greatly with aqua fortis, and burns to a brownish red. It is common on the shores in Yorkshire.

The Soft Whitish STONE, with brownish yellow partitions, is of a very soft and loose consistence, and full of great numbers of empty cracks. It is seldom above eight inches in diameter, and is of a roundish shape. Sometimes it is invested with a crust a little paler than the inside of the Stone, and when broken a few shining specks may be seen. It ferments greatly with aqua fortis, and calcines to a pure white.

The Elegant Crustated STONE, with a bluish nucleus or kernel, is of a very close even texture, and is generally about eight or ten inches in diameter, and of a roundish flattish shape. The crust is about the sixth of an inch thick, and of a pale yellowish brown, as well as the rest of the mass. The nucleus in the centre is usually about four or five inches broad, and about half an inch in diameter. It is of a pale bluish grey, and round it the substance is disposed in regular crusts, which grow thinner as they approach the centre. It ferments with aqua fortis, and burns to a pale red. It is not very common; but is found in Leicestershire.

The Hard Dusky Brown STONE, with very thick partitions, has a fine close texture, and an even surface. Its shape has a tendency to roundness, and is generally between four and five inches in diameter, with a pale yellowish brown crust, though sometimes it has none at all. When broken the surface is irregular, and looks like flint; but it has few spangles. The partitions are numerous, broad and thick, of a pale brown colour, and pretty transparent. They are all irregular, and this Stone will bear a pretty good polish. It will not strike fire with steel, but ferments most strongly with aqua fortis.

The Hard Greyish Brown STONE, with thick whitish partitions, is different from all the foregoing; for it is divided into angular squares of irregular shapes. The texture is firm and compact, and the surface irregular and rugged. The size is from four to eight inches, and it has a tendency to roundness. It seldom has a crust, and when broken does not at all sparkle. It may be generally observed, that in these sort of Stones the softer they are, the more they are spangled; but the harder, the less spar they contain. This stone is very heavy, and takes a good polish; but will not strike fire with steel, though it ferments violently with aqua fortis.

The Brown Compressed STONE, with yellow partitions, is generally of a very large size, it being from one to three feet in diameter. It is of a broad and flat shape, and seldom above four inches thick. It is sometimes invested with a thin yellowish brown crust, but is most commonly found naked. It has a reddish cast, which is owing to a slight tinge of iron, though the prevailing colour is a pure brown. It has a smooth surface when broken, but has no shining specks. The partitions consist of fine glittering spar of the colour of honey, which is disposed into columns, and is regularly and beautifully dispersed throughout the mass of the stone, dividing it into oblong angular pieces with three or four sides, and from one to two inches in diameter. It is very heavy, hard, and will bear a fine polish; but will not strike fire with steel, though it ferments violently with aqua fortis. It is common on the shores of Yorkshire, Suffex, and Kent.

The Whitish Grey and very Hard STONE, looking like flint, is of a firmer texture than any of the former, with a pretty smooth even surface. It seldom exceeds six inches in diameter, and is always of a round or oval shape. It is mostly covered with a thickish brown crust, and on the inside it is sometimes very pale, and sometimes mixed with more or less brown. It appears like flint when broken, and has no shining specks. It has but few partitions, and those very thin, and of a very pale brownish white. It is remarkably heavy, and very hard, though it will not strike fire with steel; but ferments violently with aqua fortis, and burns to a pale greyish white. It is not very common.

Bluish STONE, brown on the outside, with white partitions, is pretty hard, with a rough irregular surface; and is of various sizes, from a few inches to two feet in diameter. It is always flattish, being seldom more than six inches thick in the middle, from whence it becomes thinner to the edges every way. It is sometimes invested with a pale brown crust of earthy matter, mixed with a little spar; but is most commonly entirely naked. Wherever this stone breaks with ease, it is always of a pale brown, but elsewhere of a dusky blue or lead colour, with a few shining spangles. The partitions are of a very pure white, though sometimes a little tinged with the colour of brimstone. They are very numerous, and divide the mass into many pieces, which consist of several sides, and are from one to three inches in diameter. It is capable of a good polish, but will not strike fire with steel, though it ferments violently with aqua fortis, and burns to a pale dusky red. This stone is very uncommon.

Hard Pale Yellow STONE, with a few thin partitions, is of a pretty firm texture, but the surface is rough and unequal. It is sometimes three feet in breadth, and very flat, for it seldom exceeds two or three inches in thickness. The pale yellow is sometimes mixed with brown, and when broken its surface is pure and regular. It has a few shining spangles in different places, and is sometimes covered with a thin shell of a pale grey earthy matter. The partitions consist of a pale brown spar, disposed in short irregular columns, and generally lie in straight



straight perpendicular directions, dividing the mass into large pieces; and on each side of the cracks filled with these partitions there is often a coat of white sparry earth; for which reason this stone may be easily divided into pieces. It is pretty heavy, and will bear a tolerable polish. It is common in the middle counties of England.

1. Soft Dusky Yellow STONE, with very thick partitions, has a pretty smooth texture, but not very compact: the surface is uneven, and the size is from two inches to two feet in diameter. It is always flattish, though generally thickest towards the centre, and thinner at the edges. When it has any crust, it is always a little softer than the rest of the stone; and the disagreeable dusky yellow is mixed with a little brown. When broken it appears in irregular flakes, with a rough surface, on which are a few spangles like talc. The partitions consist of a pale yellow spar regularly dispersed through the stone, and are pretty numerous, many of which are no less than one third of an inch in diameter. It is pretty heavy, though soft, and does not ferment greatly with aqua fortis. It may be seen in the clay pits near Deptford.

The Hard Bright Yellow STONE, variegated with brown, is of a pretty fine close texture, with a very rugged unequal surface; and the size is from four to twelve inches in diameter. It is always oblong and flat, being no thicker in the middle than elsewhere. It has commonly a thick crust of the same substance with the stone, but softer; and is of a very bright beautiful yellow, with sometimes a brown coat, and at other times veined in different directions. When broken, the surface is tolerably even, and there are shining specks of spar in different places. The partitions are thin, but consist of a pale brown spar. It is moderately hard, and will take a slight polish. It is common in the tile clay-pits about Pancras.

The Very Hard, Brownish, Yellow, Undulated STONE, with a very few whitish partitions, is of a very even compact texture, with a smooth regular surface. It is from three to nine inches broad, of a flattish shape, and oftener square than oblong. When broken it has a tolerably smooth surface, with long specks of spar. The partitions are very few and small, and it is often without any. It is very heavy, extremely hard, and will bear a fine polish; but yet it will not strike fire with steel. It is common on Mendip Hills in Somersetshire.

The Hard, Greyish, Yellow STONE, is divided into pieces by thin yellow partitions, and has a very fine close texture, but the surface is irregular and unequal. It has been found from four to twelve inches broad, of a roundish flat shape, and seldom with any crust. It appears smooth when broken, with a few glittering spangles. The partitions are of a fine pale honey-colour, and are very numerous, running among each other in all directions, and forming a sort of net-work, somewhat like a honey-comb, but of various shapes. The pieces contained in these are about an inch in diameter, having from three to six sides, and the partitions consist of a transparent spar. The whole is very heavy, considerably hard, and will bear a good polish; but it will not strike fire with steel. It is frequently met with on the sea-shore.

The Round Yellow Ferruginous STONE, with thin straw-coloured partitions, has a smooth even texture, is about eight or ten inches in diameter, and in the shape of a round ball. It is always crusted with a paler colour, which is softer than the substance of the Stone, and near an inch thick. The colour is a mixture of rusty iron, and a pale yellow; and when broken the surface is smooth and even, with a few shining spar specks that look like talc. The partitions are of a beautiful colour, and

are composed of most bright pure spar, without any order. They are always thickest at the centre, and very few reach to the surface. It is considerably heavy, pretty hard, and will bear a slight polish. They may be seen in the clay pits between London and Islington.

The Roundish STONE, of a rusty red colour, with yellowish partitions, is pretty like the former, and is between six and twelve inches in diameter. It is always covered with a thick crust, of a whitish brown clayey earth, containing a good deal of spar, and is commonly about half an inch thick. When broken the surface is even, and has a few shining specks. The partitions are principally about the centre, and are of a fine bright yellow. It is very heavy, pretty hard, and will bear a tolerable polish. It may be seen in the clay pits near Islington.

The Rusty Brown STONE, with whitish partitions, has a pretty smooth texture, but not very firm; the size is from two to twenty inches, and always broad and flat. It is generally covered with a thick whitish brown crust, and the surface when broken has many shining sparry specks. The partitions are pretty regular, running through the stone in perpendicular directions. It is so soft as hardly to bear any polish, and is common on the shores of Yorkshire.

The Hard Blackish Brown STONE, with a yellow coat, has an exceeding fine texture, with a pretty even surface; and is from four to six inches in diameter, and always of an oval figure. The crust is of an ochreous clay, different from the rest of the mass, and is very brittle. It is commonly composed of thin coats laid evenly one upon another, and adhering but slightly. They are of a fine deep yellow, and are easily broken from the stone by a small blow. The body of the stone is a mixture of rusty colour and black, and when broken has a smooth flinty surface. The partitions are of a very pale yellow, and are pretty thick, dividing the stone into irregular pieces. This Stone is very common in many parts of the kingdom.

The Hard Brown STONE, with snow-white earthy partitions, has a very close texture, with a pretty smooth and even surface. It is commonly of a roundish or oval shape, and from three to twelve inches in diameter. It is sometimes naked, but oftener met with in strata, covered with a thin brown earthy crust. The colour is of a pale brown, and when broken the surface is pretty smooth, with shining specks of spar thereon. The partitions are soft and crumbly, and consist of a white marl. It is very heavy, considerably hard, and will bear a very good polish; but will not strike fire with steel. It is not very common, though it has been found in the counties of Somerset and Huntingdon.

The Hard, Rusty, Brown STONE, with yellow earthy partitions, is of a very firm compact texture, with a rough surface, and is generally flattish, and from four to ten inches broad. It has seldom any coat, but when it has, it is of a pale yellowish soft substance. The brownish rust colour is commonly spotted and clouded with black, which sometimes appears in the shape of shrubs, trees, and mosses, like those of the Mocha Stone. When broken the surface is smooth, and there are usually no sparry specks. The partitions are narrow, few and irregular; these consist of ochre and marl, of which the first is in the largest quantity. It is considerably heavy, hard, and will take a good polish, but will not strike fire with steel. It has been found in Leicestershire, Northamptonshire, and near Highgate.

The Hard, Pale, Brown STONE, with partitions of a clayey earth, is of a close firm texture, with a rugged surface, and commonly of a roundish or oval shape, and from four to twelve inches in diameter. It is often covered with a thin crust of a pale brown



colour, though it is sometimes without it. When the substance of this Stone is broken, it appears with a coarse surface of the same colour; but if according to the partitions, it is of the colour of rusty iron. The partitions are of a clayey earth, tinged with iron particles; and they are irregular and few in number: besides these there are exceeding fine cracks, in which places the Stone naturally breaks. It is very heavy, considerably large, and will bear a pretty good polish, but will not strike fire with steel.

The Soft, Pale, Brown STONE, with partitions consisting of the same substance as the pyrites, is of a pretty coarse and loose texture, and somewhat porous, with a very smooth surface. Its shape is very uncertain, though most commonly roundish, or oval, and seldom exceeds six inches in diameter. When it is broad and flat it is most commonly naked; but when roundish, it has a thick whitish crust. The surface is irregular when broken, and has a taste of vitriol, which none of the others have: the partitions are pretty numerous and irregular, but never thick, and consist of a double plate of the vitriolic pyrites. This stone may be readily divided at these partitions, as well as the plates from each other, after it has lain some time in the air; for before that it will break more easily any where else. The substance is soft and brittle, and consequently will not bear a polish.

The Rusty Red STONE, with yellowish brown partitions, has a very fine compact texture, with a very smooth glossy surface. It is of various shapes, sometimes oblong or oval, but more generally pretty much flatted, and is from three to twelve inches in diameter, and from four to six thick. Its colour is of a dusky brownish red, not always perfectly mixed; for in some places they are almost distinct, and form a sort of clouds or spots. When broken it appears to have an even glossy surface, without shining specks. The partitions are many and pretty thick, with a streaked texture, composed of an arrangement of brownish yellow columnar spar, which is pretty hard, though not very bright. The pieces divided by these partitions are of different shapes and sizes, and from half an inch to four inches in diameter. This Stone is very heavy, extremely hard, and will bear an exceeding fine polish. It will strike fire with steel, but with great difficulty, and ferments briskly with aqua fortis. It is very common in Yorkshire, and in most of the northern counties of England.

The Brownish Yellow STONE, with whitish partitions, is of a very firm texture, with generally a perfectly smooth surface. It is of various shapes and sizes, and is sometimes found in continued strata, though more commonly in irregular shapes; but always compressed and flatted, from three to fourteen inches in diameter, and about five inches thick. It is met with on the sea coast, particularly near Scarborough in Yorkshire. They have seldom any crust, but when they have it is of a rusty colour, and about a third of an inch thick. The colour of the stone is of a very fine ferruginous yellow, and when broken the surface is smooth and glossy, looking almost like flint. The partitions are numerous, and in many places thick and broad; they consist of a semi-transparent spar, which is very hard, and by these the stone is divided into a multitude of irregular pieces, from one to four inches in diameter. It is very heavy and hard, and will strike fire with steel, but with great difficulty.

The Bluish White STONE, with straw-coloured partitions, has the same texture as the two former, with a rough rugged surface. It is generally found in loose marshes, of a flattish shape, with some tendency to round or oval; but generally with rough edges, and from four to eighteen inches in breadth,

and from two to six thick. It has seldom or never any coat, and the colour consists of a mixture of blue and white. When broken the surface is glossy, and without any shining specks. The partitions are of a streaked texture, and are composed of a fine transparent bright spar, with irregular columns. It is considerably heavy, pretty hard, and will bear a good polish. It strikes fire with steel with great difficulty, and ferments briskly with aqua fortis. It is common in Yorkshire.

The Pale Yellow STONE, with a rusty-coloured nucleus, is of a pretty close compact texture, and of a roundish shape. It is about four inches in diameter, and is covered with a thin pale crust, within which there are from three to five coats of a different thickness, but all of the same substance, and much of the same colour, that is, of an agreeable pale yellow. When broken, the surface is pretty smooth, with many shining specks of spar. These coats have a nucleus or kernel in the centre, consisting of a hard ferruginous stone, and are divided from it by a thin regular partition of a straw-coloured spar, from which there run a great many other straight partitions directly to the circumference, but growing narrower as they come near it. It is pretty heavy, but not very hard, for it will not strike fire with steel. The nucleus is of a different substance from the rest, is very heavy, and of a firm texture; it strikes fire with steel, but will not ferment with aqua fortis. It consists of a large quantity of ferruginous matter, with a deep brown clay. It is to be met with on Mendip Hills in Somersetshire, and in a clay-pit near Islington.

The Brownish STONE, with a blackish brown nucleus, is of a pretty fine close texture, with a smooth regular surface, and is always roundish, though generally a little flatted. The size is two or three inches in diameter without any crust, and there is a hard blackish brown nucleus in the centre, of a close texture, contained in a thin crust of a paler colour, but of the same substance. It is about half an inch in diameter, and the crust about an eighth of an inch thick. The stone is composed of two other coats nearly of the same thickness, and of different degrees of brown. They are divided from the nucleus by a fine thin partition of whitish spar, from which others run that are straight towards the circumference, and yet but seldom pass through the inner coat. The nucleus is hard and stony, but not so much as the former, for it breaks pretty easily, and is full of small specks of loose spar. It consists of earthy and ferruginous matter, and will strike fire with steel, though with great difficulty, and will ferment a little with aqua fortis. It is to be met with in Northamptonshire, Leicestershire and Yorkshire, and has been sometimes found near London.

The Hard Whitish Grey STONE, with a brown nucleus, is of a very fine close texture with a smooth surface, and is always roundish or oval. It is generally about two inches in diameter, and is covered with a pale whitish yellow crust. The nucleus is brown and covered with a crust as hard as itself, but somewhat of a paler colour, and on its outside there is a fine sparry partition, which is firm and hard; from this there generally runs three or four narrow partitions towards the surface, which seldom reach the outer crust. It is very hard, and capable of a good polish, but will not strike fire with steel, nor yet the nucleus. It is a very uncommon stone, and hard to be met with.

The Small Ferruginous STONE, of a roundish or oblong shape, is generally known by the name of Mineral Bezoar, because it has coats like Animal Bezoar. It has a close, firm, compact texture, with a smooth surface, and is always either of a round or oblong form, generally about three quarters of an inch



inch in diameter, and from half an inch to two inches in length. They are constantly covered with a crust of a pale whitish substance of about a sixth of an inch thick. They always consist of a large central nucleus, sometimes surrounded with two or three coats of ferruginous matter, and sometimes irregularly blended with it, making together a single nucleus surrounded with a crust. Both the nucleus and the crust are generally divided into three, four or five parts, by pretty large cracks, which are widest on the outside, and usually become narrower as they approach the centre. They are commonly empty towards the surface, but near the centre they are filled up with a fine transparent spar. The Stone itself is pretty hard, and will bear a pretty good polish. It will hardly strike fire with steel, and ferments but very little with aqua fortis. It is common in the brick and tile clay-pits in all parts of England.

The Oblong, Pale, Brown STONE, with a long hollow nucleus, is of a very close firm texture, with a rugged unequal surface. The shape is oblong and cylindric, only it is largest in the middle, and becomes gradually less towards each end; but for half an inch they each terminate in a small cylinder of almost a whitish colour, and of a harder substance than the other parts. This is nothing but a lengthening of the inward substance, being only the extremity of the nucleus. It is between seven and eight inches long, and yet the diameter is three inches where thickest. The nucleus consists of a long cylindric tube, terminating in a blunt point at each end, which is sometimes empty, and sometimes filled with a white marl, or the matter of the stone that contains it. It is of a ferruginous colour, and is inclosed in a thin crust of a brownish substance, which is surrounded with a single, double, or triple partition of beautiful spar, and this again with two thick crusts consisting of the same substance as the rest of these stones. It is divided by three or four partitions, running like rays from the circular partition straight towards the circumference, but they generally vanish in the first and second coat. The whole is surrounded with an unequal whitish brown coat about a third of an inch thick. The cavity of the nucleus is half an inch in diameter, and the nucleus itself about an inch. This Stone is subject to a great number of cracks lying in different directions, so that when struck it will fall into many pieces, not more than the tenth of an inch in thickness each. The nucleus is very heavy and hard, but will not strike fire with steel, any more than the body of the Stone. The partitions consist of a pure white spar, which appear very bright when just broken. It has been found hitherto only in a great tile clay-pit near Oxford road, about three quarters of a mile beyond Tyburn.

The Very Hard Smooth STONE, with yellow, brown, and red coats, has a very fine compact texture, with a pretty smooth surface, and is remarkably heavy. Its shape is roundish or oblong, and the size is from a quarter of an inch to three or four inches in length; but most commonly of the shape and size of a pigeon's egg. It is sometimes found naked with a somewhat glossy surface, and at other times covered with a whitish crust. It consists of five or six coats, which inclose a firm solid hard nucleus of the same substance, that is sometimes of a deep dusky brown, and sometimes of a strong though not bright red; at other times it is composed of both these colours, either blended or in spots. The coats are alternately brownish, yellowish and reddish, that next the nucleus being brown, the next yellow, and the third reddish, with another that is yellow, and over these one that is brown. However, they sometimes vary in the disposition. It is very common in clay and gravel-pits, and particularly about London,

when covered with a crust. One fourth part of this Stone is iron.

The Hard, Glittering, Rough STONE, with brown, purple, and deep yellow coats, is of a coarse, uneven, and very irregular texture. The shape is always oblong, but of different lengths and thicknesses; it is from half an inch to eight inches long, and about three quarters of an inch in diameter. It has a rough surface made up of small prominences and cavities, less than the heads of the smallest pins; but this is uncommon, for it is usually stuck full of small pebbles. It is pretty hard, and breaks with a rough surface, and there is a nucleus surrounded with eight or ten coats, some of a paler, some of a deeper brown; others of a dusky and somewhat reddish colour, and others again of a deep brownish purple; but they are placed without any order or regularity. It is pretty bright and sparkling, not only when just broken, but on the surface; and the whole substance of the coats is full of small shining spangles like talc. It is common in the gravel-pits about Oxford, as well as in other places, and contains a small quantity of iron.

The Soft, Brownish, Yellow STONE, is almost as soft as earth, but is very compact, of a smooth texture, and considerably heavy. It is of a flattish oblong shape, and round at the ends; and is most commonly four inches long, two broad, and one thick. It is oily to the touch, and breaks with an irregular but smooth surface. It contains a nucleus of the same shape as the stone, and of the same colour, surrounded with coats of the same, which are extremely thin and exceeding numerous. It has no crusty covering, nor does it at all sparkle. It ferments very briskly with aqua fortis, and burns to a beautiful pale red. It is very uncommon, but has been seen in the potters clay-pits in Staffordshire, and in the forest of Dean.

The Soft STONE, with shining brown and dusky green coats, consists of a coarse opaque substance, and is of a loose texture. It is remarkably heavy, of an oblong shape, and commonly about an inch and a half in length, somewhat in the form of a ninepin. It is harsh and rough to the touch, the surface being extremely uneven, and when broken it has an irregular and pretty rough surface. It is generally composed of four coats, surrounding a nucleus of the same substance and shape as the stone. This is surrounded by a brown broad coat, and that by another that is broader. The next is a very beautiful one, it making a fine glittering appearance, and is of a very pale brown colour; over all there is a coat of dusky brown clay, which is always rugged and unequal. It is very common in clay-pits in many parts of the kingdom, and particularly in a clay-pit near London behind Black-Mary's-Hole.

The Soft STONE, with shining, whitish, yellowish and red coats, is of a loose brittle texture, and moderately heavy. It is commonly oblong, rounded at the ends, and of the size of a pigeon's egg. It is very rough, and will readily break with a small blow; it has from four to six coats of the same loose texture, but of different colours; but there is always one that sparkles, and is composed of the matter of the common selenites. The nucleus is commonly whitish, though sometimes with a mixture of yellow, and is of the same shape with the stone. The coat which immediately surrounds the nucleus is generally yellow, the next red, and the next whitish; then one that is yellow, and over these is the outermost, which is composed of great numbers of small columnar selenites, that together appear almost like crystal. It is very common in the clay-pits of Northamptonshire, and may be met with in several other counties.



## C H A P. XXVIII.

## Of the Hardest Common STONES.

**THE Hard, Shining, Black and White STONE,** is of a very irregular structure, but extremely firm, with a smooth though not glossy surface. It is from eighteen to twenty-five inches in diameter; but of different shapes, which all tend to be round, oval, or flat. At first sight it appears to be only of a dull yellowish white, and a glossy black. The white specks are sometimes slightly tinged with a flesh colour, others are of a cream colour, and others again shine like pure crystal. The surface is of a dull dead colour, but it is very bright and sparkling when just broken. It is considerably heavy, very hard, and will take an excellent polish. It strikes fire with steel, but will not ferment with aqua fortis. It is common on the shores of the island of Guernsey, and is met with in many places on the English coast. It is used in paving the streets of London.

The Hard, Shining, Red and White STONE, is of much the same texture as the former, but of a better colour, and the shape tends to roundness or an oval. It is found often of twenty or thirty inches in diameter, with a very smooth surface; and the colour is a pleasant light red, and sometimes a flesh colour, interspersed with small parcels of a pure bright white, from one eighth to one fourth of an inch in diameter. When broken it is smooth, bright, and beautiful; and is so hard that it will bear a very fine polish, as well as strike fire with steel. It is brought from the shores of Scotland, and is used in London for paving the streets.

The Red STONE variegated with white and black is of the same texture with the two former, and has a smooth, bright, glossy surface. Some are eight inches in diameter, and the shape is generally oblong and flattish. The colours are all beautiful and bright, the ground being red, variegated with all the different degrees and forms of a white transparent and black crystalline talc, which are so various in different stones, that they do not seem to be of the same kind. It is considerably heavy and hard, will take a fine polish, and strike fire with steel. They are found on the shores of Guernsey island, and brought to London to pave the streets, where they may be easily distinguished by their surfaces after a shower of rain.

The Hard, Heavy, Greyish Black STONE, variegated with white, is of a more rude, irregular, and harsh texture than any of the former, though it is more compact and hard. The surface is smooth and even, but not glossy, and is generally about ten or twelve inches in diameter; but the shape is uncertain, though it is commonly flat on one side. It is not so beautiful as the former, being of a greyish or bluish black, with opaque but very bright white, distinct from each other, yet regularly intermixed throughout the whole stone, so that it seems to consist of a regular mixture of black and white. When fresh broken the surfaces are remarkably smooth and bright, and it will bear a high polish. It strikes fire with steel, but will not ferment with aqua fortis, nor suffer any great alteration by fire. It is found on many parts of the shores of Yorkshire, and is sometimes seen in the streets of London.

The Brownish Red STONE, variegated with white and yellow, is of a pretty even fine texture, sometimes from three to four feet in diameter, and of a somewhat oblong and flattish shape. The ground is of a reddish brown colour, which is variegated with an impure talcky crystalline matter; generally about an inch long and half an inch in diameter; that is either of a pure or yellowish white; and these variegations are often four or five inches distant from

each other. It is pretty hard, will take a good polish, and strike fire with steel, but does not ferment with aqua fortis. It is found on the surface of the earth in Yorkshire and other counties.

The Reddish White STONE, variegated with black and gold colour, is of a more loose texture than any of the former, and very coarse. It is generally found between four and eight inches in diameter, and is of a very irregular shape, being seldom round, oval or flat. The colour is either a pale flesh, a deeper red, or entirely white. The particles of which this stone is composed seem to be a crystal debased with earth, and more or less of a metalline tinge, of the size of a horse-bean. Among these, black and yellow variegations are dispersed, which are composed of crystal, earth, and talc, of different degrees of brightness. It is considerably hard, very heavy, and capable of taking a fine polish. It is common on the shores of Yorkshire.

The hard White STONE, variegated with brown, is of a very coarse harsh texture, but extremely firm and hard, with a smooth glossy surface. The size is from two to ten inches in diameter, and it is generally of a roundish or oval shape. The ground is of a dusky white, variegated with pale brown; but they are distinct from each other, and interspersed with a great many flakes, some of which consist of a pure crystal lined with talc. When fresh broken, it glitters very much, especially in the white parts; it strikes fire with steel, but will not ferment with aqua fortis. It is common in Westmoreland and Yorkshire.

The Bluish, White, Bright, Brittle STONE, contains more talc and less crystal than the former; for which reason it is of a flaky texture, though very irregular, and the surface is rough and uneven. It is from ten to fourteen inches in diameter, and of a very uncertain shape, being generally rough and jagged at the ends and edges. Its colour consists of a dark bluish grey, and a pretty pure opaque white; the former of which is the ground, though sometimes it happens otherwise. It is composed of different masses, as in the other kinds; and those that are stony or crystalline are much of a size, and seldom larger than a horse-bean. It is but light in comparison of the rest, and is very brittle. It does not at all seem proper for polishing, though its stony parts will strike fire with steel; but it will not ferment with aqua fortis, and when burnt it is whitish with a silvery gloss. It is common in Yorkshire and the neighbouring counties, where the common people make use of it in the winter nights to keep the bed warm, or rather their feet, to which it is laid after it has been heated; for it will retain the heat a considerable time; and they give it the name of the Warming-Stone.

The Brown Brittle STONE, variegated with yellow, is very beautiful, with a pretty fine even texture, but more loose than the former, and with a rough surface occasioned by prominences and cavities. It is of various sizes, but seldom exceeds six inches in diameter; and the shape is quite irregular, though it is sometimes flat, and tending to an oval. The distinct parts of which it consists are seldom above one twelfth of an inch in length; and they are all of the same colour in the same mass, which is of a pale brown; among these are a great number of talcky flakes that are extremely bright, which are sometimes intermixed with spangles of black and whitish talc; but they are so uncommon, that brown and yellow may be said to be the true colours of the stone. When broken it appears extremely beautiful; but it is so soft as not to be capable of a good polish, and therefore will not readily strike fire with steel. It is found in many parts of Sussex and Yorkshire, and has been seen on Hampstead Heath.



The Hard, Purplish, Brown STONE, variegated with white and yellow, has a very rough, coarse, uneven texture; but it is firm and hard, with a rough unequal surface. It is commonly found from ten to eighteen inches in diameter, and the shape always approaches to round or oval, with a smoothness or flatness on one side. The colours are generally brown and white, or brown and yellow. The brownish purple parts make the ground, and consist of considerably large pieces, that are perfectly opaque. Those that are white and yellow are smaller, more bright, and in some degree transparent, they being composed of a mixture of crystal and talc. It is a little bright when fresh broken, and is very hard; for it will readily strike fire with steel. It is common on the shore near Scarborough, and has been sometimes seen in the streets of London.

The Hard Bluish Green STONE, variegated with white, is the most beautiful of the whole class. It is of a pretty firm, fine, but unequal texture; and in many places is loose, irregular, and porous. The surface is very smooth; the usual size is from three to four inches; and it is of a round or oval shape, but always flattened on one side. The greenish particles, of which the Stone chiefly consists, are all of a crystalline substance debased with earth, and tinged with metalline particles. Its variegations are small masses of white, consisting of crystal and talc, and debased with very little earth. It is very beautiful when broken, and is extremely heavy and hard; but it will not admit of a perfect polish, because its texture is a little porous: however, it readily strikes fire with steel. It is found on the shores of Suffex, but is most common in Wales, and contains a pretty deal of copper.

## CHAP. XXIX.

Of STONES approaching to the Nature of Flint.

**T**HE Yellowish White STONE, filled with pebbles, commonly called the Pudding-Stone, is of various shapes, according to the various pebbles it contains. It has been by some ranked among pebbles, but improperly; for they are no part of the Stone itself, which is a distinct species, and different from all others. The sementitious substance is an opaque Stone, of a very fine, close, and firm texture, with a pretty smooth surface on the inside, though in the masses it is frequently very rugged and unequal. In size it is from that of a walnut to three or four feet in diameter, with some tendency to roundness. It is of a pale yellowish colour, and when broken the surface is smooth, even, and flinty. It is pretty heavy and very hard, and consequently will take a very beautiful polish. It will readily strike fire with steel, but does not ferment with aqua fortis. The pebbles contained in it are of various kinds and sizes, from that of a pin's head to the bigness of a walnut. It is found in many parts of England, particularly in Hertfordshire, and is used for the tops of snuff-boxes and other toys.

The Greyish White STONE, filled with pebbles, is finer and harder than the former, but is very opaque, and has an exceeding smooth glossy surface, for it resembles a smooth spotted pebble. It seldom exceeds ten inches in diameter, and its shape is almost always roundish all over. The pale greyish white colour often contains more of blue than pure white, and the surface is very smooth when broken. When cut into thin pieces it is somewhat transparent, and is capable of a beautiful polish. It readily strikes fire with steel, but will not ferment with aqua fortis. \* It is almost always found in gravel-

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pits among flints and pebbles, and is used for snuff-boxes like the former.

The Red STONE, filled with pebbles, is of the same nature with the two former, and is very opaque, with a pretty coarse texture and a rugged surface. It is found from six inches to four feet in diameter, and of very irregular shapes. The colour is a deep red, and sometimes there are different shades in different parts of the same piece. When broken, it is scarce at all bright or glossy, and its fineness is generally in proportion to its colour, for it is greatest where that is least. It will readily strike fire with steel, but will not ferment with aqua fortis. The pebbles it contains are of various sizes and kinds, and not so perfectly joined to the mass as in the other species; they are, however, not easily separated from it, and therefore it is as fit for use as any of the former. It is common in Lincolnshire, Derbyshire, and Yorkshire, but is seldom brought up to London.

The Brownish STONE, filled with pebbles, is of the same kind as the former, but is more impure and coarse. It is perfectly dull and opaque, with a rough harsh texture, but yet pretty firm; and the surface is rough, rugged, and unequal. It is from two to five feet in diameter, and is of a very irregular shape, though it sometimes shews a tendency to roundness. The colour is always of a dusky brown, but in various degrees. It is not so heavy as the former, though it strikes fire with steel. It contains very small, as well as some large pebbles, which are generally a little flattish. It is common in Leicestershire.

The Flesh-coloured STONE, filled with reddish impure crystalline nodules, is of a coarse, harsh, loose texture, and somewhat porous, with a rough irregular surface. It is found from four to twelve inches in diameter, and the shape is almost always flattish. It is generally so full of the masses it contains, that it is hard to find a speck of the pure cement of the bigness of a pea. Its colour is a very pale whitish red, and the surface when broken is uneven without any gloss. It strikes fire with steel, though not without some difficulty; but does not ferment with aqua fortis. The nodules are all of the same kind, but of various sizes, from the bigness of a pin's head to an inch in diameter. There is a great number of them, and they lie in different directions. Those that are large are easily struck out of the cement, leaving a pretty smooth cavity behind. These nodules consist of a sort of crystalline particles. This Stone is common in the sides of hills in Yorkshire.

The Bluish Glittering STONE, filled with white impure crystalline nodules, is of a pretty coarse, harsh, uneven, and irregular texture, with a rough surface; and is of various sizes, from one foot to four or five in diameter, and generally of a flattish shape. The colour is a deep dusky blue or lead colour, and there are many bright glittering spangles. The surface is roughish when broken, and it seems to be a-kin to some of the lime-stones. It is very heavy, moderately hard, and capable of a very good polish. It readily strikes fire with steel, and ferments a little with aqua fortis. The crystalline masses are the same as those in the former Stones, only they are without any colour. It is found in many parts of Leicestershire, as well as on the shore near Scarborough; but is never put to any use.

The Whitish Green Beautiful STONE, filled with crystalline nodules, has a pretty fine, close, firm and hard texture, with a rugged unequal surface, without the least gloss or brightness; and the crystalline nodules generally stand pretty far out of their cement. Its size is from two inches to two feet in diameter, and its shape is generally flattish, seldom inclining either to round or oval. The colour is a pale whitish grey, irregularly tinged with a very beautiful



beautiful green; though it is not diffused through the whole Stone, but appears in the form of specks and clouds. It has a rough and wrinkled surface when broken, without the least transparency; and in breaking of it the nodules get out of their places, leaving cavities behind. They are generally smooth, but not glossy; and they seldom exceed the size of a small pea. They are outwardly of a very deep green, but within are white and opaque. They consist of a tabulated spar, and the green colour is owing to the mass in which they are included. This stone is moderately heavy and pretty hard; but it will not take a good polish, nor yet strike fire with steel without difficulty. It is found on the shores of Minorca, and now and then on the English coast.

The Brittle, Pale, Red STONE, variegated with white veins, and containing red nodules, is the softest and most brittle of this class, with a coarse loose texture, and a rough irregular surface. It is of various sizes, for it has been found from one to thirty inches, and is always flattish. The red colour is different in different masses, it being sometimes of a brick colour, while other parts are of a pale flesh. When broken, it is in many places perfectly spongy, without the least brightness, except in the white veins, which are not many. The red nodules are from the size of a pin's head to that of a hazle nut, and consist of the same substance as the stone itself. The stone is not proof against water, and will scarce give fire with steel. It is common in the shores about Scarborough.

## C H A P. XXX.

## Of Flinty STONES.

THE Common FLINT is a stone universally known, and of a very fine compact texture, with a surface that is generally rough and rugged, with various protuberances. The size is different, from an inch to two or three feet in diameter. The shape is extremely irregular, it being in gravel-pits of the form of a common pebble; but in chalk, where it is found in greater plenty, it is met with in all shapes. It is always covered with a white crust, which is sometimes very thin, and sometimes one sixth of an inch thick. It consists of crystal, debased with a large mixture of white earth, of the clay kind. The substance of this stone is uniform and equal, and is generally blackish, though sometimes grey. When broken it is of a fine even glossy surface, is semi-transparent, and will bear a fine polish. It is met with in all countries, and is put to various uses.

The White Flinty STONE is pretty fine, with a smooth compact texture, and a smooth surface, only it is furrowed with shallow wrinkles. It is generally roundish, but sometimes oblong, and its size is from half an inch to eighteen inches in diameter. The colour is uniform throughout, which is always white, with a small bluish cast. It is not equally pure, nor of the same degree of transparency; for some resemble the white cornelian, and others the common ground of agate. The coat is sometimes a little reddish, but is more commonly grey, or of a greyish brown. When broken it appears to have a fine even flinty surface; and, as it is very hard, it will bear a good polish. It will readily strike fire with steel, but will not ferment with aqua fortis. This is a common stone in many parts of England.

The Red Flinty STONE is of a very fine firm texture, with a surface not so even as the former; for it has deeper wrinkles, and often many prominences and cavities in different parts. It is generally roundish, and from an inch to three inches in diameter. It is naturally uniform, being without

spots, clouds, or streaks, and its colour is very fine, but it is of different degrees of red in different stones, as well as of different degrees of purity. It has sometimes small, whitish, opaque spots, and some are brighter and more transparent than others. It often nearly resembles the different cornelians, and has generally a whitish coat, with a small mixture of ash-colour, or yellowish brown. When broken, it appears to have a flinty surface, is very hard, and capable of a good polish. It strikes fire readily with steel, but will not ferment with aqua fortis. It is very common in our gravel-pits, and many of the seals sold for cornelian are made therewith.

The Yellow Flinty STONE is of a very fine even texture, and is extremely firm; but the surface is rough and irregular, it being full of wrinkles and other inequalities, and the shape is generally rugged and unequal. The size is from one inch to seven in diameter, and it consists of crystal, debased with a yellow earth, to which it owes its colour. They are sometimes of a deep yellow, and sometimes inclining to a whitish grey. It resembles the yellow cornelian, and is often equal to the finest stones of that kind; but is sometimes subject to imperceptible flaws, which will make it fly to pieces when broken. However, the surfaces are fine and glossy, and it is more transparent than the former; as it is very hard, it will take a fine polish. It readily strikes fire with steel, but will not ferment with aqua fortis. It is not very common, but has been found on Hampstead Heath.

The Bluish Flinty STONE is of a pretty smooth and close texture, with a rough irregular wrinkled surface and a very uncertain shape. It is generally about two inches in diameter, and is not of so simple a colour as the former; for it is of different degrees of blue in the different parts, some of which are deep, and others approaching to white, appearing in clouds, spots, and short lines. It is without cavities or cracks, and its outer coat is of various colours, but generally with a white and chalk-like appearance; sometimes it is of a bluish brown, and sometimes very thick and yellow. It is pretty hard, will take a good polish, and freely strike fire with steel. It is very common in gravel-pits.

The Greenish Flinty STONE is not so close and compact as the former, nor yet so fine, though the surface is pretty smooth and even. It is generally of a roundish or oblong shape, and from half an inch to two inches in diameter. It is always of the same colour, without either spot or cloud, which is of a deep dusky and somewhat bluish green. It is sometimes of the colour of green jasper, but has a coarse look, as it contains a great deal of earth. The coat is generally thick and white, and sometimes of a bluish dusky grey. When broken the surface is even, and as it is very hard, it will bear a good polish. It readily strikes fire with steel, but will not ferment with aqua fortis. It is not very common, and consequently is but seldom found.

## C H A P. XXXI.

## Of STONES that outwardly appear like PEBBLES.

THE Stone called PEBBLE CRYSTAL has a very smooth equal texture, it being in reality nothing else but Crystal in this form. It is free from all mixtures, and is found from the size of a pin's head to twelve inches in diameter. It is generally pretty round, though sometimes not without irregularities on the surface, and is sometimes flattish. It has a close firm texture, is pretty heavy, and as transparent as water. It is very hard, is capable of a very



a very high polish, and when broken is very bright and glittering. It strikes fire with steel, but does not ferment with aqua fortis. They are found almost in all parts of the world; but are most common in America, where they are very large, and are generally known here by the name of Brasil Pebbles. They are found in that country on the banks of rivers, as well as in Germany, Italy, and France. They are also met with in England; but their size is very small. Spectacles are made with this stone.

The Purple, Half-transparent, Crystalline STONE, has a rough uneven texture, but it is very firm, with a smooth surface; it is generally between an inch and four inches in diameter, and of a roundish shape, a little flattened. It is of an unpleasant yellowish white on the outside, but is pretty heavy, and when broken the colour is a reddish purple, very bright and glittering. The colour is not uniform, but appears sometimes in blotches, and sometimes in veins, in such large quantities, that they seem to tinge the whole mass. It is not quite so hard as the former, but will strike fire with steel. This is found in rivers and gravel-pits, and has been brought from Germany and Bohemia. It is said also to have been met with in gravel-pits near London.

The Snow-white, Opaque, Crystalline STONE, is of a very smooth, firm, and close texture, with a smooth even surface: its size is generally between a quarter of an inch and two inches, and though it is sometimes round, it is more frequently oval and flattish. It is as white as chalk on the outside, is pretty heavy, and when broken the colour is bright and shining, and as white as snow. It consists of a homogeneous substance, and is extremely hard. It freely strikes fire with steel, but will not ferment with aqua fortis. It will take a very fine polish, and is common in the gravel-pits of Norfolk.

The Opaque, Whitish, Reddish or Yellowish Crystalline STONE, commonly known by the name of the red, white, and yellow sparry Pebble, is the most common stone we have. It consists of a rough irregular and opaque substance, which is pretty firm and compact in its texture, with a pretty smooth surface, though often full of cracks, which sometimes penetrate deep into the body of the stone. It is met with from the size of a pea to six or seven inches in diameter, and is inclinable to a roundish shape, though it is sometimes flattish, especially on one side. The colour is much the same without and within, and it is irregularly tinged with different colours. These are sometimes uniform throughout the whole substance of the stone, but sometimes appears in spots, blotches, and irregular veins. It has a little brightness when broken, and appears to be of a loose texture. They are to be met with in gravel-pits and other places all over the kingdom.

The Yellowish, White, Spungy STONE, has somewhat of the nature of sand-stones hewn out of quarries, inasmuch that it might be mistaken for a fragment of that kind. The texture is coarse, but pretty firm, though there are small cavities that give it some resemblance of a sponge; the surface also has the same appearance, and it is generally from half an inch to two inches in diameter. It is pretty heavy, and more or less of a yellowish white, without the least brightness. It is composed of an irregular crystalline matter, debased with a mixture of a whitish and yellowish opaque substance. Though it is pretty hard, it will not easily strike fire with steel, nor does it ferment with aqua fortis. When examined with a microscope it appears to be a petrified sponge, for there are more cavities than solid matter.

The Hard, Porous, Whitish, Crystalline STONE has a rough cavernous and spungy surface; but it has not so many pores on the inside as the former kind. There are veins on the outside, dispersed in

an irregular manner, of different breadths, and often interwoven with each other; likewise they all stand up in ridges above the surface of the stone. Sometimes the pores on the inside are wanting, which renders the texture the more firm; it is from one inch to six in diameter, and generally of a flattish shape, though somewhat roundish. It is naturally white, and sometimes has a mixture of faint red, or pale yellow. It is pretty heavy, very hard, and is glossy when broken, especially in its veins, which are more close and compact than the rest of the mass. It strikes fire with steel, but will not ferment with aqua fortis.

The Greyish, White, Opaque STONE, is of a very close texture, with a smooth even surface; but it is subject to cracks of various sizes, and is from an inch to a foot in diameter, sometimes roundish, and sometimes flat; but in this last case it is always subject to superficial cracks. It is perfectly opaque and dull when broken, though it consists of an uniform crystalline substance, debased by a mixture of white and grey clay. It is very heavy, pretty hard, and will readily strike fire with steel. This, as well as the two former, is commonly in gravel-pits.

The Brittle, White, Sandy STONE, is of a very loose brittle texture, with a pretty smooth regular surface, though it is somewhat rough to the touch; the shape is irregular, though generally flattish, and the size is from one to twelve inches in diameter. It is pretty heavy, and when broken appears of a bright glittering white. It consists of a great deal of pure white sand, to which it may be reduced, and it breaks with the slightest blow into a great number of pieces. It is readily penetrated by water, which will pass through it unchanged. It will not ferment with aqua fortis. It is not very common, but has been found in the gravel-pits of Northamptonshire.

The White Crystalline STONE, with yellow specks, is by some called the Worm-feed Stone. It is of a pretty hard compact texture, and generally has a smooth surface, though sometimes there are irregular cavities. It is of a roundish or oblong shape, and thicker at the middle than at the edges. It is commonly about three or four inches in diameter, and the colour is generally white, though it has sometimes a pale brown cast. The specks are about the breadth of a small pin's head, and are of a very bright pale yellow, by which characteristic it is easily distinguished from all other stones. The colour is dull on the outside, but bright and glittering when broken; and it consists of a large angular grit, extremely well united. It strikes fire with steel; but does not ferment with aqua fortis. It is common in Yorkshire, and is sometimes found in the gravel-pits near London.

Whitish, Brown, Dull STONE, is softer than any of the former, and yet the texture is pretty even and regular. It is generally above a foot in diameter, and its shape is always broad and flat, with deep longitudinal cracks on the surface, which are crossed with some that are smaller. It is of a very pale brown, and has sometimes a faint yellowish or reddish tinge. The surface is dull and opaque, and when broken is generally full of cracks, the largest of which are often filled up with crystals, which look very bright and glittering. It is pretty heavy, and is harder in some places than others. It is found in many parts of England, and particularly on Hampstead Heath, very deep in the ground. It sometimes contains large pieces of petrified wood, which are so stony that they cannot be perceived, except by the knots.

The Blueish, White, Hard, Crystalline STONE, is not of a very fine structure, but firm and close, with a smooth surface. It is generally from three to ten inches in diameter, and of a flattish shape, somewhat



what approaching to roundness. It is of a dull light lead colour on the outside, but when broken is bright and glossy, and the thin pieces are a little transparent. It is very heavy, will take a fine polish, and readily strikes fire with steel. It is very common on the shores of Italy, France, and England.

The Brownish, White, Hard, Shining STONE, is pretty coarse, but very firm, and has a rough irregular surface. It is about six or seven inches in diameter, though sometimes much smaller, and at other times extremely large. It is of a dusky white on the outside, with a small mixture of pale brown; but when broken it is bright and glittering, with an unequal surface. It consists of a grit with blunt angles, together with roundish bright particles, cemented together with a substance nearly as bright. It is sometimes full of black and green specks, of the size of very small grains of sand. It is pretty heavy, and capable of a good polish; but it will not strike fire with steel. It ferments violently with aqua fortis, which discovers its nature, which is that of consisting pretty much of spar. It is found in Derbyshire.

## CHAP. XXXII.

### Of Common PEBBLE-STONES.

**T**HE Yellowish Green PEBBLE, with a bluish white crust, is of a fine close texture, and the surface, though regular, is a little wrinkled. The shape is roundish or oblong, and the size from one to five inches in diameter. It has commonly a large nucleus in the centre, inclosed in a broad coat, which is covered with a very thin crust. The nucleus is of a greyish yellow, sometimes perfectly blended together, and sometimes irregularly mixed in the form of clouds or large spots. There are often white opaque spots dispersed here and there, and the nucleus approaches to pure flint. The coat next to it is of a bluish white, and of a somewhat coarser texture. The external crust is of a whiter colour, and is of the same substance, only there is a greater mixture of earth. When broken it has a smooth glossy surface, and the nucleus is pretty transparent. It is very hard, will bear a good polish, and strikes fire with steel. It is found in the gravel-pits in Northamptonshire, and sometimes in those near London; however, when found, it is of no value.

The Whitish, Grey, and Reddish Coated PEBBLE, with a yellow centre, is more beautiful than the former, and has a fine close texture, with a pretty even surface, though full of wrinkles. It is of a flattish round shape, and the common size is about three inches in diameter. It is composed of a large nucleus, which is the principal part of the stone, and is of a deep bright yellow, and pretty transparent. It is sometimes marked with roundish white spots, from the bigness of a pin's head to that of a pea, and is surrounded with a coat of a pale greyish white, of a flinty substance, which sometimes receives the matter of the nucleus into itself in the form of clouds, making a broad undulated line. This is generally covered with a red coat, and that with the external crust, which consists of a great quantity of earth. When broken it has a glossy surface, and is hard enough to take a polish. It is very common on Hampstead Heath, and in many other places.

The White, Black, Brown, and Straw-coloured PEBBLE, with a yellow nucleus, is a very beautiful stone, and of a fine texture. It is generally of a roundish or oval shape, and seldom exceeds three inches in diameter. The nucleus is large, and is the principal part of the stone. It is surrounded with several coats, which resemble the zones of the

onyx. The nucleus is very bright, and pretty transparent, and of a deep but not bright yellow. It is sometimes of the same colour throughout, and has clouds of a different yellow and flint colour, also opaque specks of a palish white, and sometimes likewise the centre is transparent crystal. The nucleus is usually surrounded with a narrow black circular line, and is covered with a coat of a paler yellow than the nucleus, and that by another of an opaque white; the next is of a pale brown, besides which there are four or five others of the same colours placed alternately. These are all covered with a bluish crust, but sometimes with a whitish, and always greatly wrinkled. When broken, the surface is glossy and pretty transparent, is very hard, and will bear a good polish. It strikes fire with steel, but will not ferment with aqua fortis. It is common on Hampstead Heath.

The Whitish, Bluish, and Brown PEBBLE, with a dull brown nucleus, has a close firm texture, with an even surface, only it is wrinkled. It is generally of a roundish or oval shape somewhat flattened, and the size is from one to five inches in diameter. The nucleus is pretty large, of a deepish brown, and of a pretty fine texture, but not very transparent or bright. It is commonly surrounded with a broad whitish coat, then with a narrower of the same colour as the nucleus; after that is a third of the same substance with the inner coat, and these are covered by one of a bluish colour, of a more flinty texture than the other part of the Stone, over which there is a crust like the rest, but more earthy. When broken the surface is very bright and glossy, and as it is pretty hard, it will bear a good polish. It is common on Hampstead Heath, and in the gravel-pits about London.

The PEBBLE, with white and brown coats, and a shining brown nucleus, is a very pure and beautiful Stone, and has a fine close texture, with the common wrinkled surface of other Pebbles. It is generally of a round or oval form a little flattened, and commonly four or five inches in diameter. The nucleus is very large and oblong, and of a deep bright pleasant brown. It is transparent, though sometimes subject to whitish specks. It is surrounded with a coat of a milky white, sometimes mixed with a little pearly blue; and next to that is one of the same colour with the nucleus, only it is not so transparent nor bright. Over this is the crust that covers the whole, and in general it is not inferior to an agate. When broken, it has a bright glossy surface, and where thin is pretty transparent; it is extremely hard, capable of a fine polish, and will strike fire with steel. It is found in gravel-pits, but is not so common as the former.

The PEBBLE, with white, brown and yellow coats, with a small brownish yellow nucleus, has a fine close texture, with the wrinkled surface of other Pebbles. It is commonly roundish or oval, and the common size is about an inch in diameter. The nucleus is about as big as a small nutmeg, and is surrounded by a coat of a dull opaque impure white, and that with one of a pale whitish brown; the next is of a pale red or flesh-colour, and the fourth of a blackish brown. The outer crust is a pale yellow, and as thick as any of the rest. The nucleus is pretty bright, but has little or no transparency; however, this Stone, as well as all others, is subject to some varieties. It is very hard, will bear a fine polish, and readily strikes fire with steel. It is pretty common in the gravel-pits about London, and might be put to good uses by the lapidaries.

The PEBBLE, with greyish white, pale brown, and reddish coats, with a small brown nucleus, is of a very fine close texture, and has the wrinkled surface common to other Pebbles. The shape is roundish or oval, and is commonly four or five



inches in diameter. The nucleus is usually of the size of a nutmeg, and of a deep brown colour. This is covered with a coat of a pale whitish grey, and that by another that is of the like but thinner, and next to these there are generally four or five of the same colour as the nucleus, and others of a very pale whitish brown alternately disposed. It is more transparent than most other Pebbles, and when broken has a flinty surface; it is very hard, will bear a good polish, and strikes fire with steel. It is common in the gravel-pits on Hampstead Heath.

The PEBBLE with yellow, red, and bluish white coats, with a reddish brown nucleus, is of an exceeding fine firm texture, and is not so wrinkled on the surface as most of the other kinds. It is of a roundish flattish shape, and commonly about three inches in diameter; the nucleus is pretty large, of a very fine texture, and pretty bright and transparent. It is of a pale red, and is inclosed in a coat of a fine pearl colour or bluish white, which is pure, bright, and transparent; next to this is a fine red coat, and after that several pearl-coloured and red coats alternately placed; over these there are three or four coats of a pale yellow, and the outer crust is of a pale bluish colour. It is more transparent than most other Pebbles, and when broken has an even surface; it is very hard, will bear the highest polish, and readily strikes fire with steel. It is common in the gravel-pits about Kensington, and many other places. It is in some use with our lapidaries.

The PEBBLE, with white, orange, brown, and dusky yellow coats, and a brown nucleus, is of a very fine close texture, with a wrinkled surface, like the rest of the Pebbles. It is of a roundish or oval shape, and from one to three inches in diameter. The nucleus is small, and the coat that immediately surrounds it is of a clear white. The next to that is orange, and then there are eight or ten of different colours, composed of brown or yellow, after which are colours of a dusky white, with a fine orange colour between them. The whole is very pure, bright and transparent, though it is subject to many variations. When broken it has a fine glossy surface, is extremely hard, and consequently will bear a very fine polish. It is common in the gravel-pits on Hampstead Heath, and in many other places about London.

The PEBBLE, with whitish, brownish, and yellowish coats, and a brown nucleus, is of a more coarse texture, than any of the former, though pretty firm and hard. The surface is more smooth than that of other Pebbles, and is generally pretty round, and between two and three inches in diameter. The nucleus seldom exceeds the size of a horse-bean, and is surrounded by an irregular undulated coat, composed of others that are narrow; next to this are three or four others, which are composed partly of a very deep brown, with some that are yellowish, and others of a dusky pale blue. They have all a mean appearance, and are perfectly opaque. They are very scarce, and are of no value.

The PEBBLE, with yellowish, brown, and ash-coloured coats, and a bluish white large nucleus, is a very beautiful stone, and has a fine firm texture with a wrinkled surface. It is generally roundish, and from one to four inches in diameter. The nucleus is large and very beautiful, and sometimes makes the principal part of the stone. It is of an exceeding fine texture, and very bright and transparent, approaching to a white cornelian. It is of the colour of pearl with a bluish white, which is often debased with clouds, spots, and veins of an opaque white. This is surrounded with a yellowish brown coat that is clear and transparent, and then there is another of a pale ash coloured grey as fine as the former: these are surrounded with the outer crust, which is of a bluish or ash colour; however, the coats and the

stones are met with in different proportions. It is more transparent than any of the rest, is very hard, will take a fine polish, and strike fire with steel. It is common in the gravel-pits on Hampstead Heath, and about Windsor.

The PEBBLE, with flesh coloured, brown, and bluish white coats, and a fine large white nucleus, has a fine, close and firm texture, and the surface has only some slight wrinkles; the shape is roundish or oval, and generally about two or three inches in diameter. The nucleus is oblong, and not so blue as that of the former, but is as fine, bright and transparent. It is encompassed with a great number of coats of a pale brown, bluish white, and a pale white light red placed alternately, and covered with a whitish crust. They seem all to be of an equal degree of brightness and transparency; but it is subject to great variations. It is hard enough to strike fire with steel, and will bear a very fine polish. It is common in the gravel-pits of Hertfordshire, and is used in London to make tops for snuff-boxes.

The PEBBLE, with red, flesh coloured and yellow coats, and a white nucleus, is a fine beautiful Stone, and of a very close texture, with a wrinkled surface like that of other Pebbles. It is generally roundish, though sometimes oblong, and is commonly about three inches in diameter. The nucleus is commonly pretty large and opaque, though of a very fine texture, and is frequently full of coarse roundish white spots. This is commonly encompassed by a thin bright red coat, and that by one of a beautiful bright yellow, next to which there is another of a flesh colour, and then four, five, or six others of the same colours, but not placed in an alternate order. They are all very bright, and more transparent than the nucleus. When broken, the surface is fine and smooth, is very hard, and will take an elegant polish, as well as strike fire with steel. It is common in the gravel-pits on Hampstead Heath.

The PEBBLE, with very thin, numerous, brown and yellow coats, and a greyish white nucleus, is of an exceeding fine close texture, with a surface not so much wrinkled as in other Pebbles. It is generally of a roundish shape, and from one to four inches in diameter. The nucleus is large and of a fine texture, but not quite so transparent as the rest of the Stone. The grey and the white are sometimes distinct, and at others blended together; but is subject to small grey opaque spots. The coats are many in number, but only of a pale brownish yellow and a dusky brown colour placed alternately. They are bright, beautiful, very transparent, and covered with white opaque dull crusts. It has a glossy surface when broken, is very hard, will bear a fine polish, and will strike fire with steel. It is common among gravel in Hertfordshire.

The PEBBLE, with brown, yellow and white coats, and a greyish white nucleus, is of a fine close texture, with a rugged wrinkled surface; is generally oblong and flattish, and from one inch to five in diameter. The nucleus is sometimes no bigger than a horse-bean, though the Pebble be large; and yet it is sometimes an inch broad in smaller. The surface is glossy, but very opaque, encompassed by many fine regular coats of a fine deep brown, a very pale yellow with a little mixture of brown, and a fine white. The brown is next to the nucleus, and the other colours are placed alternately, but tinged more than one at a time. Its surface is glossy when broken, and, as it is very hard, will bear a good polish, and strike fire with steel. It is common on Hampstead Heath, and in the gravel-pits about Islington.

The PEBBLE, with white, grey, and flesh coloured coats, and a very white nucleus, is of an even close



close texture, with a very rough wrinkled surface, and a flat roundish shape, from two to three inches in diameter. The nucleus is of various sizes, from the bigness of a pea to that of a walnut, and is of a fine texture, but opaque and dull, as are all the other colours. It is irregularly surrounded with many coats of different thicknesses and different colours. When broken, it has a smooth but not a glossy surface, and is so hard as to be capable of a good polish, and strikes fire with steel. It is common in the gravel-pits about London.

The PEBBLE, with brown, ferruginous, and yellow coats, and a brownish white nucleus, is one of the coarsest of this kind; but the texture is hard and compact, and the surface is not so wrinkled as many others; however, there are several prominences and cavities, which render the shape irregular, though it is generally somewhat oblong. It is from one to four inches in diameter; and the nucleus is sometimes so pale, that it is almost white. It is encompassed with four or five coats, whose colours are very good: that next the nucleus is of a rusty coloured brown, the next to that pale brown; after which is another of a rusty brown, then one of a deep yellow; the next is brown, and then comes the crust, which is of a pale whitish grey. It appears rough when broken, and is so hard as to strike fire with steel. It is not very common, though it has been met with in different places.

The PEBBLE, with brown and grey coats, and a bluish nucleus, is of a very fine firm texture, with a smooth surface, and not so much wrinkled as many others. The shape is oblong, and from one to three inches in diameter. The nucleus is of a pure flinty substance, sometimes of the same uniform colour, but more frequently veined or spotted with a lighter or darker colour of the same kind. This is encompassed with a fine deep brown coat, which is very bright; and that is succeeded by one of an ash colour, as bright as the nucleus. The crust is next to these, which is pretty thick. It has somewhat more of a transparency than most of this kind; and as it is extremely hard, it is capable of a good polish. It is met with in some parts of Hertfordshire.

The PEBBLE, with thick, whitish, and red coats, and a grey nucleus, is of a very fine texture, but the surface is rough, irregular, and deeply wrinkled. Its shape generally tends to roundish, and it is most commonly an inch and a half in diameter. The nucleus is hard, bright, glossy, and transparent; the next coat is usually red, with a little mixture of rusty brown, and is not so transparent as the other parts of the stone; next to this is a coat of a bluish white or pearl colour, very bright; after this comes the crust, which is thick, coarse, of a very bright white, and of a loose stony substance. This is the common appearance of the stone, and sometimes the coats are more numerous. It is very hard, the substance being flinty, and capable of the highest polish. It is not common; but has been found in Northamptonshire, and near Paddington.

The PEBBLE, with white, flesh-colour, and bright red coats, and a bluish white nucleus, is of a fine close even texture, with a very rugged wrinkled surface, and a roundish shape. It is not above two inches in diameter, and the nucleus is surrounded with many white, flesh-coloured, and red crusts, beautifully disposed, but not always alternately; though that next it is generally red, and they all together have a very fine effect. This stone is generally very bright and transparent, and when broken has a smooth glossy surface; it is very hard, and will bear a fine polish. It is very common on Hampstead Heath.

The PEBBLE, with brown, yellow, and flesh-coloured coats, and a greyish blue nucleus, is of an exceeding fine smooth texture, with a surface a little

wrinkled, and is of a roundish or oblong shape, but a little flattened, and seldom more than three inches in diameter. The nucleus is very beautiful, bright and transparent. It is encompassed with many coats of a pale brown, and a fine red, which sometimes is of a flesh colour, and also of a somewhat dark yellow. It is often debased with small coarse spots, and perhaps more than any other. When broken, it is of a fine glossy surface, is extremely hard, and capable of a very fine polish.

The PEBBLE, with white, yellow, flesh-coloured, and red coats, and a greenish blue nucleus, is undoubtedly the most beautiful of the English Pebbles, for it comes up to the German Agates. The texture is exceeding fine, smooth, and hard, with a surface less wrinkled than most other kinds. The shape is roundish or oblong, and from three to four inches in diameter. The nucleus is pretty large, and sometimes round, but more commonly oval. It is of a very fine texture, with a glossy surface, and in thin pieces quite transparent. It is generally of a deep bluish green, which is sometimes so dark as to appear almost black, and often of a dusky blue: it is likewise sometimes of so bright a green, that it is not inferior to the green jasper. The coats are fine, and beautifully disposed like the zones of an onyx, and are all bright and transparent. Some are of a bright white, others of a fine deep yellow, others of an agreeable pale flesh colour, and others again of a bright deep red. The coats are very thin, and lie evenly throughout the whole substance of the stone; but the flesh colour and white are most commonly near the nucleus, and the yellow towards the surface: however, like most others, it is subject to great varieties. It is more transparent than any other Pebble, and when broken is of a fine even flinty surface, capable of bearing the most perfect polish. It is common in many parts of England, in particular near London in the road to Highgate, and formerly was in great plenty among the gravel in the foot-path from Pancras to Kentish-Town. It is sometimes used by our lapidaries, but not so much as it deserves.

The PEBBLE, with whitish, brown, and yellowish coats, and a flesh coloured nucleus, is of a fine and smooth texture, with a very firm, rough, unequal, thick crust, it being full of prominences and cavities. The shape is very irregular and uncertain, it being ragged and uneven in several parts, and looking more like a flint than a pebble. The size is from an inch to eight in diameter, and the nucleus is pretty large, with a shape like that of the stone itself. It is of an agreeable flesh colour, with a slight tinge of blue, and the coats are not above three or four in number, which are of a fine deep brown, a dusky white, and a pale and darkish yellow. The yellow coat lies next the nucleus, the white next to that, and then the brown; and in some a thick yellow coat lies over these, bounded by a very narrow one of deep brown. The surface is of a pale whitish brown, and extremely coarse, being often half an inch thick. It is pretty transparent, when broken has a fine flinty surface, and is so hard as to bear a very good polish. It may be met with in Yorkshire.

The PEBBLE, with white and brown coats, and a white nucleus, is of a very fine close texture, with a rugged unequal surface, having prominences like warts, with small irregular cavities and deep wrinkles. It is commonly of a roundish, oblong, flattish shape, and from two to three inches in diameter. The nucleus is bright and white, but not very clear; and the number of coats is uncertain, being sometimes three or four, and at other times six or eight; which are all of two colours, a fine deep brown, and a very bright white. The brown parts are very bright and glossy, and pretty transparent; but the white is much



much more opaque. When broken it is bright and smooth, and being extremely hard will bear a pretty fine polish. It is very common in the gravel-pits of Northamptonshire and Leicestershire.

The PEBBLE, with black, white, and flesh-coloured coats, and a red nucleus, is of an exceeding fine close texture, with a smooth even surface, the wrinkles being very superficial. The shape is generally roundish, and seldom exceeds three inches in diameter. The nucleus is encompassed with many thin coats of a fine jet black, a clear white, and a flesh-colour. The black is commonly next to the nucleus, then the flesh-colour, and after that the white; but it is sometimes one, and sometimes the other: the rest follow alternately, though not always. The outermost coat is generally of a flesh-colour, and over that is the crust, which is very thin. The nucleus is of a fine bright transparent red, and equal to many of the best cornelians. The flesh-coloured parts are the most opaque of any in the stone; but the black coats are extremely beautiful, being very bright and glossy, and when thin are pretty transparent. When broken the surface appears to be flinty, it being extremely hard, and capable of an excellent polish. It is not very common; but it has been found on Hampstead Heath, and in the gravel-pits of Northamptonshire.

The PEBBLE, with yellow and greenish white coats, and a yellow nucleus, is of a very fine close texture, with a remarkable smooth surface, it having only a few superficial wrinkles. It is generally pretty round, and between one and three inches in diameter. The nucleus is small, but of a fine texture, a glossy surface, and pretty transparent. It is of the colour of the common yellow cornelian, and encompassed generally with but a small number of coats of two colours, namely, a yellow a little deeper than the nucleus, and a very pleasant whitish green, of which colour the coat next the nucleus always is, and after that is a yellow, next a green, and so on alternately. The outer coat, on which the thin crust is laid, is sometimes of a pale brownish white, but not always; besides which there are often other varieties. The nucleus and the yellow coats are transparent, and much more so than the green. It is extremely hard, capable of a fine polish, and readily strikes fire with steel, like the rest of this kind. It is very uncommon, but has been seen on the shores of Yorkshire.

The PEBBLE, with purple and pale yellow coats, and a red nucleus, is of a fine firm texture; but the surface is remarkably rough, being full of inequalities, though it has but a few deep wrinkles. The shape is irregular, and the size various, some being less than an inch, and others four inches in diameter. The nucleus is also irregular, and of a strong deep red, though pretty bright and glossy, but with little transparency. It is surrounded by two or three coats of a fine pale yellow, and a purplish black colour; which last, held up to the light, appear of a fine deep purple. All parts of the stone are bright and glossy, but those that are yellow are most transparent, and there is generally a yellow coat next the nucleus: those that follow are commonly placed alternately, and are pretty thick; there is likewise a yellow one next the outward crust, which is white within, and yellowish on the surface. This stone is always exceeding hard, and when cut into plates is very transparent. It is very uncommon; but some have been found on the shores of Sussex, and in the gravel-pits about Oxford.

The PEBBLE, with grey and pale red coats, and a yellow nucleus, is pretty fine and firm, with a smooth even surface, only there are superficial wrinkles. It is generally roundish, and from one to six inches in diameter. The nucleus is of a dusky yellow, and commonly about the size of a hazle nut.

It is opaque, has a curdled look, and is surrounded by several coats of a pale red, placed alternately with some that are thicker, of a pale ash-colour or bluish grey, not unlike some of the paler flints. The pale red or flesh-colour is made so by a mixture of grey, and the outermost coat is usually of this last colour, over which there is a pale bluish grey crust. This is coarse in comparison with one of the former, though it is pretty hard, and takes a tolerable polish. It is found in great plenty on the shores of Yorkshire, and sometimes in the gravel-pits about London.

The PEBBLE, with red, purple, bluish, and brown coats, and a pale grey nucleus, is not of so fine a texture as any of the rest, though it is pretty smooth, and very firm, with a surface furrowed with deep wrinkles. It is commonly of a roundish shape, and about four inches in diameter. The nucleus is of a pale grey, or whitish ash colour, encompassed with a great number of thin coats of several colours, as a deep red, a bright purple, a greyish blue, and a glossy brown; these last are more transparent than any of the rest: but these, upon the account of their coarseness, have but a dull look, which renders the stone less beautiful. The coat next the stone is of a red colour, and thickish, but not clear or bright; next this is one of brown, but the rest of the coats are disposed without any regularity, though they are very prettily variegated. The outer coat is generally of a bluish grey, and thicker than the rest; but the crust is commonly very thin and whitish. It has a smooth flinty surface when broken, and is so hard as to take an even polish. It is not common, though it has been sometimes met with in Hertfordshire.

The PEBBLE, with black and white coats, and a black nucleus, is of an exceeding fine close texture, with a rough surface, generally full of deep wrinkles and protuberances, of the size of a horse-bean. It is of a flattish round shape, and commonly four or five inches in diameter; the nucleus is pretty large, and of a fine glossy black. The coats are of a pearl colour, and black like the nucleus, and placed alternately; but the whitest are the thinnest, and the outermost is always black, and thinner than the rest. The crust that covers the whole is generally very thick, and seems to be of a coarse chalky substance. It is more transparent than any of the former, it being extremely hard, and when broken has a fine glossy surface. It will bear a very good polish, and like the rest strikes fire with steel, but will not ferment with aqua fortis any more than they. It is pretty common on the Sussex and Yorkshire shores. It is sometimes made into seals and other toys, and looks like an oriental stone.

The PEBBLE, with brown and greyish black coats, and a yellowish brown nucleus, has a pretty fine firm texture, though the surface is rough and unequal, and deeply wrinkled. It is commonly of a flattish round shape, and from two to six inches in diameter. The nucleus is large, and of a brownish yellow, or tawny, surrounded with a few thick coats, some of which are of a greyish black, and others of a pretty clear brown. The nucleus is generally surrounded with a pale grey coat, after which the brown and darker grey are placed alternately. The outermost coat is always brown, though but thin, and the crust that covers it is thin and bluish, but of a much paler colour on the protuberances, than on the other parts. It is not very transparent, but has a glossy surface when broken, and is so very hard as to be capable of a good polish. It is to be met with in the gravel-pits of Hertfordshire, Buckinghamshire, and Northamptonshire.

The PEBBLE, with white and greenish coats, and a pale grey nucleus, is of a pretty fine texture, and very firm, with a smooth surface, without many wrinkles.



wrinkles. It is almost always round, and is from one to three inches in diameter. The nucleus is small and round, and encompassed with coats of two colours, some of which are entirely white, and others of a faint greyish green; but a white coat is generally next the nucleus. Sometimes these colours are blended with each other, and have undulated edges running through one another, to the succeeding coat; the outermost coat is of a paler or greyer green than the rest, and but thin, as well as the crust that lies over it, which is of a pale bluish ash colour. It is but little transparent, though it breaks with an even surface; however, it is so hard as to bear a pretty good polish. It is found on the shores of the river Thames, and sometimes in the gravel-pits about Islington.

The PEBBLE, with yellowish brown and black crusts, with a brownish white nucleus, is the Egyptian Pebble of the lapidaries. It has an exceeding fine close texture, and the surface is not so wrinkled as many of our Pebbles. It is commonly of an oblong shape, though sometimes very irregular; it is of various sizes, but the most common seems to be about four or five inches long. The nucleus is of a very irregular shape, and of different sizes, but is always of a pale whitish brown, and sometimes with veins or spots of a dusky colour. It is also often variegated with the colours of black trees, shrubs and mosses. When it is large, it spreads itself so much as to have some resemblance to a beast or fish, or at least some of their parts; likewise some have had the distinct representation of a human face. The nucleus is commonly surrounded with a pretty thick crust, of a pale brownish yellow, and that by one of black; these are encompassed with others which are many in number, partly black, and partly of a deeper or paler yellow. Every part is much of the same degree of purity; but, if any, the black is finer than the rest. It is met with in Egypt, Arabia, and some of the islands of the Archipelago. There is a species of this kind in Germany, and some parts of Suffex, but they are not so fine as the Egyptian.

The PEBBLE, with yellow and pale brown coats, and a deep green nucleus, is very beautifully variegated, but is not so pure as some of the former, and is of a pretty coarse, rough, unequal texture, though it is tolerably firm, and has a smooth surface, with very few wrinkles. It is generally roundish, and from one to five inches in diameter. The nucleus is large, and of a dark dusky green, surrounded by a number of crusts in different stones, which are also different in their thicknesses. Some are of a deep yellow, and others of a pale whitish brown, disposed alternately; but one that is whitish, or very pale, usually surrounds the nucleus, and the outer coat is commonly yellow, and pretty thick; the crust is always whitish, and has a chalky look, but not very thick. The surface when broken is not very smooth, and yet is so hard as to bear a good polish. It has been found on Hampstead Heath, and about Kensington.

### C H A P. XXXIII.

#### OF SANDS and GRITS.

**F**INE Shining White SAND is generally made use of to dry up the wetness of the ink in writing, lest it should blot, and for this reason is almost universally known. It is pretty fine, and is generally found very pure, and of a pretty fine white. It has some brightness, and, if it be very good, is a little sparkling, and the particles seem to be much of a size. It feels a little rough between the fingers, and settles very quick when mixed with water; but

viewed through a microscope the particles appear to be of very different sizes and shapes, though they are all somewhat angular. They are all white, and though some are opaque, many are as transparent as crystal glass. It makes no fermentation with aqua fortis, nor yet any of the rest, and therefore this circumstance needs not be repeated. It is found in many parts of England, in strata of great depth; but as there are some of yellow sand lying near it, it is no great wonder it should be sometimes mixed therewith. It is of great use in making glass, but not so good as that with flint; however, it does not require so laborious a process. Sands in general will serve for the same purpose, and they are made use of in some counties to manure stiff clay lands; for though they are barren of themselves, the lands are rendered fertile by their mixture, because they are thereby made more susceptible of water, which otherwise would not penetrate stiff clay. This likewise is the principal part which bestows firmness to bricks, tiles and stone. It is also of great use in making mortar, which commonly unites the joints of bricks and stones, and renders them immoveable. Likewise Sand mixed with mud or clay will make a sort of mortar, but less durable, though often used in the country for the walls of cottages. It is also Sand that gives a consistence to potters clay; for otherwise it would crack when wrought into vessels, and consequently fall in pieces, or at least the vessels would be useless. It sometimes serves for polishing the hardest bodies, and for cleaning those that are tarnished.

The Large Shining White SAND is coarse, with respect to the former, though it is generally very pure. It is of a pretty good white, with some brightness and sparkling, and seems to consist of regular uniform particles, which are harsh and rough to the touch. When mixed with water it settles immediately, leaving no foulness behind it. All the particles are of a somewhat oblong and irregularly angular shape, and when viewed through a microscope, the surfaces appear to be smooth, and as transparent as white glass. It is of great value among those that make glass, and is commonly brought out of Kent to London.

Fine White very Shining SAND is the best of all of that colour, it being perfectly pure, pretty heavy, and of a pure white, and is very remarkable for its lustre. It is composed of very uniform particles with even surfaces, and is extremely hard. When thrown into water it sinks immediately, without leaving foulness behind it. When viewed through a microscope, the particles appear to be a little oblong, and of irregular angular shape, with a fine clear water, it being little inferior to the purest crystal; and indeed this and the two former are entirely of that substance, except, as some suppose, there is a small mixture of white earth. It is found on the shores of most of the rivers in Italy, and is of great value in glass-making.

Fine brownish white dull SAND is pretty heavy, but does not shine to the naked eye, for it appears rather like a heap of fine dust. The particles seem to be very regular and uniform, with regard to their size and shape; however, when it is mixed with water it does not subside with such speed as the former, and leaves a whitish muddiness behind it. When viewed by a microscope, the particles appear to be of different shapes and sizes, but chiefly roundish, some of them having rough surfaces, and others flattish; but they are all more or less transparent. It is found in Suffex and Kent, but is not made use of for glass, because better sorts are plenty.

Yellowish White Fine Dull SAND is pure, and pretty heavy; but has no brightness. The particles are very small, and seemingly very uniform and regular;



regular; to the touch it seems to be softer and finer than most other sands, and yet mixed with water it soon subsides to the bottom, but leaves a yellowish muddiness behind it. When viewed through a microscope, the particles appear to be of irregular shapes, though they have somewhat of a roundness, and the surfaces of many are rough; they are transparent in different degrees, and the colour is not quite the same in all, for some are almost without any. It is met with in all parts of the world.

Reddish White very Fine Dull SAND, is pretty heavy, and of a whitish colour, tinged with a little flesh-colour. It has not the least brightness, and the particles seem to be all of a size, though they are exceeding small, and feel harsh to the touch. Shaken together with water, it subsides very slowly, but when thoroughly settled it leaves no muddiness behind; however, when viewed through a microscope, the particles appear to be of different shapes and sizes, some of them being at least twenty times smaller than the rest. They are all more or less transparent, and some of them are perfectly so. There are some of this sort in England, particularly in Suffex.

Large Brownish White Shining SAND contains a mixture of coloured particles, and is coarse, heavy, and of a colour which seem to be made up of a mixture of brownish, yellowish and whitish, with a faint reddishness. It is very bright, and its particles, though of different colours, seem to be much of a size to the naked eye. When shook with water it immediately settles, without leaving any foulness. When viewed through a microscope, the particles still appear to be much of a size, and of an oblong shape with angular edges; but there are some that are roundish, and of a fine clear yellow; some dusky, but very beautiful, and some of a pale flesh-colour. The white particles are perfectly transparent, but the reddish are almost opaque. It is found at Hedgerly near Windsor, where it lies among loam.

Large Yellowish White Shining SAND consists of pretty large coarse particles, which are very heavy, though somewhat less than the former. It is very clean, and remarkably bright and shining, and feels very harsh between the fingers; when mixed with water it subsides immediately, without leaving any muddiness. When the particles are viewed through a microscope, they appear to be of all shapes and figures, though in general they have a tendency to roundness; but they are much of the same size. They are generally transparent, and are chiefly white, mixed with some of a pale yellow or lemon colour. It is found all over England, and particularly near Deptford, Highgate and Hampstead.

Large, Coarse, Shining, Variegated SAND, is a very common sort, and is a beautiful Sand, though not pure. It differs in its coarseness and fineness, and in the different shapes of the particles. It is pretty heavy, and of a transparent white colour, variegated with black, red and brown, and of a chalky white, as also with different shades of yellow. The white particles, which are much the most numerous, have a considerable brightness, and feels very hard, though not so rough as some others. When viewed through a microscope, it appears to be mixed with small pebbles, that are opaque and of different colours, besides fragments of larger pebbles and flints, with many pieces of the white opaque crusts of flints. It is sometimes found in strata by itself, and at other times mixed with gravel. That on the sea shore is always clean and bright, and mixed with fragments of shells; in this last case it will ferment with aqua fortis, which is owing to the shells mixed therewith.

Fine, Dull, Brownish, White SAND, with heterogeneous particles, is of a dead disagreeable colour; but is pretty fine, though not so heavy as many other

Sands. There is little or no brightness, excepting a very few white glittering particles, which are here and there interspersed, and which are certainly of a different nature from the other particles. The principal part seem to be pretty uniform with regard to their size, and the whole does not appear so harsh as other Sands; when shook together in water it subsides but slowly, and leaves a brownish foulness behind it. The shining particles, when examined by a microscope, appear to be fragments of talc, for they will not ferment with aqua fortis. It is common almost every where, and is mixed with lime and hair to make mortar for plastering walls and cielings.

Fine, Dull, Greenish White SAND, with heterogeneous particles, is pretty fine, though it has a dirty look, and the heterogeneous particles are not many. It is very heavy, is of a deep brownish white, with a sort of a greenish cast, and does not at all glitter except where the heterogeneous particles lie, which are certainly of a talcky nature. The other particles are not all of the same size, and the whole feels hard and harsh between the fingers; when mixed with and shook up with water it settles but slowly, and leaves a whitish brown muddiness. When examined by a microscope, it appears to consist of particles of all shapes and sizes, but mostly with smooth surfaces, and of a different colour. They are generally transparent and of a glossy white; but there are many of a sort of greenish brown, and not so transparent. It is common near Deptford, Black Heath and Woolwich. This is pretty much used for the making of green glass.

Fine Glittering Greyish White SAND, with heterogeneous particles, owes its brightness to the great quantity of talc it contains; for the sandy particles are small and fine, and seem to have little or no transparency. It is pretty heavy, and the particles are irregular in their sizes, but all of them small. The talc also is of different sizes, but larger than the sand, though at the same time very thin. It feels hard and harsh between the fingers, and when it has been mixed with water and shook up, it subsides in a short time, and leaves the water clear. When examined by a microscope, the particles seem to be of three different kinds; for besides the talc, there are some that have a glossy appearance, and a few that consist of an opaque spar; for which reason it will ferment a little with aqua fortis. It is found on the shores of the islands of Scilly.

Large Shining Red SAND consists of coarse heavy particles, and is of a strong red, approaching to a deep orange colour. It is not quite so bright as some of the white sands, but the particles which compose it seem to be pretty much of the same size, though of various shapes, with a tendency to roundness. It feels extremely hard and harsh, and when mixed with water subsides immediately, leaving it clear. It is a foreign sand.

Large Shining Flesh-coloured SAND is pretty coarse, very heavy, and is of a bright agreeable pale red, or rather of a flesh-colour. It is remarkably bright and sparkling, and the particles appear to be pretty much of the same size, though not all exactly of the same colour. It feels very harsh and rough, and when mixed with water subsides immediately, leaving no foulness behind. When examined with a microscope, some have glossy surfaces, others are quite transparent, and others again entirely opaque; many are semi-transparent; and, with regard to the colours, some are white, others yellow, and others of a pale red. It is common near Naples.

Coarse Shining Brownish SAND, with a reddish cast, consists of large but pure particles which are very heavy, and seemingly roundish. It is remarkably bright and sparkling, and the particles are of very different sizes. It is no wonder it is very rough to the touch, nor that it subsides immediately in



water. It is common on the heaths of Suffex and Buckinghamshire.

Fine, Bright, Shining, Brownish Red SAND, is very heavy, and the brown colour is more predominant than the red. The particles seem to be nearly of the same size and shape, and it feels harsh to the touch; when mixed with water it sinks pretty soon, and leaves a whitish muddiness behind it. It is met with in many parts of England, and particularly on Hampstead Heath.

Very Fine, Pale, Shining, Brownish Red SAND, is not of an agreeable colour, but is pure, though not so heavy as many other Sands. It is pretty hard to the touch, and subsides but slowly in water, leaving a reddish brown muddiness behind it. It is common on the heaths of Suffex.

Very Fine Pale Red SAND, with heterogeneous particles, is heavy, and of a very pleasant colour, which consists of a mixture of white, pale brown, and pale red. It glitters pretty much, and is composed of small uniform particles, with a slight mixture of talc. It is harsh to the touch, and when mixed with water settles but slowly. When examined by a microscope, the particles appear to be roundish and quite transparent. In the fire it loses all its redness, which is a circumstance not very common.

The Fine Palish Brown Yellow SAND makes but a dull appearance, though it is pure, fine, and pretty heavy. The colour seems to be made up of white, pale brown, and pale yellow, which are all very dull. The particles are of different sizes, and so small that they seem soft to the touch, and settle very slowly in water, leaving a whitish muddiness. When examined with a microscope, some of the particles appear to be perfectly transparent, and others almost opaque. It is very common all over the kingdom.

The Fine Shining Pale Yellow SAND, is pretty heavy, and of a fine colour, made up of white, yellow, and reddish brown. It is bright and shining, and the particles seem to be tolerably uniform. It is rough to the touch, and settles but slowly in water, leaving a yellowish muddiness behind it. When examined by a microscope, the particles are found to have different degrees of transparency, and those that are angular are as clear as crystal. It is found about Hampstead and Highgate.

The very Fine, Shining, Pale Yellow SAND, is considerably heavy, and there is no mixture of any other colours with the yellow. It is also very clean, with uniform particles, which shine pretty much. It is harsh to the touch, and when mixed with water quickly subsides, and leaves it clear. It is found in Kent and Suffex, and other parts of England.

The Fine, Shining, Gold-coloured SAND, is very pure, and heavy, and is of a fine bright yellow resembling the colour of gold. It glitters pretty much, and seems to consist of uniform particles. It is harsh to the touch, and settles immediately in water, leaving it clear. It is common on Hampstead Heath, and in most other parts of the kingdom.

The very Coarse, Shining, Pale Yellow SAND, consists of very large heavy particles, and is generally pure, with an uniform colour. It glitters very much, but the particles are irregular with regard to their size. It is very rough to the touch, and subsides in water immediately. This is commonly called Scouring Sand, and is used by stone-cutters in cutting their hard stones: it also serves to polish those that are designed for the more curious sorts of pavements. It is common in most parts of the kingdom, and particularly may be met with at Hampstead and Highgate.

The very Coarse, Dull, Whitish Yellow SAND, is generally found among gravel, and is remarkable for its coarseness. It seems to have no brightness,

unless viewed very nearly, and its particles are of very different sizes. It is common about London, and in most other parts of the kingdom.

The Large Shining Yellow SAND, is also common among gravel, and is quite pure, though coarse and heavy. It shines pretty much, and the particles are tolerably regular with regard to size. It is extremely coarse to the touch, and when mixed with water settles immediately, leaving it clear. When viewed through a microscope, it seems to consist of particles like small pebbles, with pretty smooth surfaces. It is common about London and other places.

The very Coarse Bright Yellow SAND, is always found at considerable depths, and is perfectly pure, though remarkably coarse and rough. The particles are heavy and regular in their size, and perhaps it feels the roughest of all Sands; when mixed with water, it settles immediately, leaving it clear. Viewed through a microscope, it appears to consist of large crystalline particles of an amber colour, and of the shape of pebbles. It is found in Northamptonshire, and other places, under the strata of gravel.

The Large Dull Yellow SAND, is of a disagreeable colour, though generally pure. It is considerably coarse, very heavy, and of a little deeper yellow than the former, but is very far from being so bright. The particles are of a very irregular size, and though considerably hard they do not seem so harsh as any of the former. When mixed with water they quickly subside, leaving a little yellow muddiness. When viewed by a microscope, the particles seem to resemble pebbles; but many of their surfaces are very unequal and somewhat flattish, and others crooked. It is a common Sand, and is found not only in pits, but on the shores of the English rivers. It is used by the plumbers in London as a bed whereon to cast their sheet lead, and is generally brought from Hackney river. It is also used by stone-cutters, in sawing their marble.

The Fine Dull Deep Yellow SAND, is pretty fine, though the particles are of different sizes. It is lighter than most other Sands, and the deep yellow colour is entirely without brightness. It is soft to the touch, and when mixed with water subsides very slowly, leaving a yellow muddiness behind it. When viewed through a microscope, the particles seem to be of the shape of common pebbles, with very irregular surfaces; they are pretty transparent, and of an amber colour. Some of the particles are so small, that they appear like dust sticking to the surfaces of the rest. It is common in Wiltshire, and is found in other parts of England.

The Very Large Dull Saffron-coloured SAND, is very pure, hard, coarse, pretty heavy, and of a deep strong bright yellow. The particles are not all of the same size; it is hard and rough to the touch, and when mixed with water subsides immediately, leaving it clear. It is found on the Gold Coast of Guinea in Africa.

The Coarse, Shining, Dirty, Yellow SAND, is very pure, large, heavy, and of a deep dusky yellow. The particles glitter pretty much, and seem to be regular and uniform, with regard to their size. It is harsh and rough to the touch, and when mixed with water quickly settles, leaving it clear. When viewed by a microscope, the particles appear in the shape of pebbles, and are pretty transparent, though of different degrees of yellow. It is common on Hampstead Heath, and many other parts of the kingdom.

The Very Coarse Brownish Yellow SAND, is very large, harsh, and considerably heavy; the colour is of a deep, dusky, brownish yellow, but very bright and sparkling. The particles, with regard to size and shape, are very regular, and exceeding harsh to the touch; when mixed with water it soon subsides, and



and leaves a brownish yellow muddiness. When viewed through a microscope, the particles appear to be uniform, and in the shape of pebbles, with very uneven surfaces, but pretty bright and transparent. It is common among the gravel in many parts of England.

The Fine Greenish Yellow Pale Dull SAND is of a faint straw colour, with a mixture of green particles, which are generally the largest. The sizes are very irregular, and it is soft to the touch; when mixed with water, it subsides slowly, and leaves a white muddiness therein. When viewed through a microscope, the particles appear to be different in shape, size and colour, and the greatest part have uneven surfaces. Some are of the colour of sulphur, others without any colour at all, both of which are very transparent; but the largest are in shape like common pebbles, without much transparency, and of a deep dusky green. It is found on Hampstead Heath, and many other places.

The Fine Greenish Red Pale Dull SAND, in many respects, resembles the former; but it is considerably lighter than most others, and of a pale yellowish flesh colour, with a mixture of green specks. The particles are of different sizes and shapes, those that are green being considerably larger than the rest, and it is hard and rough to the touch. When mixed with water it subsides but slowly, and leaves a yellowish brown muddiness therein. It is common in Suffex.

The Very Coarse Shining Blackish Yellow SAND is large, considerably heavy, and of a deep yellow, but mixed with black particles. It is very bright and shining for one of this kind, and the particles are nearly of the same size, only those that are black are a little smaller than the rest. It is remarkably rough, and harsh to the touch, and when mixed with water settles immediately, leaving it extremely clear. When viewed by a microscope, the particles appear in the shape of common pebbles, and are very bright and transparent, except the black, which are almost opaque. It is common in sand-pits.

The Fine, Shining, Blackish, Straw-coloured SAND, is neither large nor heavy, and the straw-coloured particles are mixed with those that are black. It is very bright and shining, considering the smallness of its particles; but these are of different sizes, and those that are black are somewhat larger than most of the rest. It is hard to the touch, but not very rough, and when thrown into water subsides very soon, leaving a little brownish muddiness therein. When viewed through a microscope, the particles appear to be of an oblong, blunt, angular shape, and are all very transparent and bright; and even the black particles, which are not very numerous, have some degree of transparency; but they are of a roundish shape, with smooth surfaces. It is common in Suffex, and may be met with in many other places.

The Shining, Coarse, Blackish, Sulphur-coloured SAND, is hard, heavy, and of a fine brimstone colour, with a considerable mixture of black. The particles are bright and shining, but irregular with regard to size, and are very harsh and rough to the touch; being mixed with water, it subsides immediately, leaving it clear. When viewed with a microscope, the particles appear to be in the shape of pebbles, but are very transparent, and the black seems to be nothing else but fragments of dark coloured flints. It is common in the sand-pits on Hampstead Heath.

The Shining Fine SAND, of a rusty yellow colour, is very heavy, and of a deep dusky yellowish brown, with a mixture of white particles, and others that have no colour at all. The brightness is owing to the last mentioned particles, for those that

are yellow and brown are entirely dull. They are all very irregular, with regard to their size and shape, and are very harsh to the touch: being mixed with water, they subside very soon, and leave a muddiness therein, as if mixed with ochre. When viewed through a microscope, they all appear to be somewhat angular, and the greatest part are of the colour of rusty iron, and entirely opaque.

The Finest Brown Yellow SAND, with heterogeneous particles, is light, and of a pale brownish yellow, with small spangles of talc, which are not very numerous; is sharp and harsh to the touch, and when mixed with water subsides slowly, but leaves it clear. When viewed with a microscope, the particles appear to be roundish, with unequal surfaces nearly of the same size, and very bright and transparent. The spangles appear to be thin flakes of fine talc, having the appearance of silver. It is common in the sand-pits on Hampstead Heath.

The Very Fine Yellowish Flesh-coloured SAND is very heavy, and the colour seems to be made up of a pale yellow, and a very pale red: when mixed with a great number of small glittering particles, those that are sandy have also some brightness, and are pretty uniform with regard to size; when mixed with water, it subsides very slowly, leaving a yellowish muddiness therein. When viewed with a microscope, the particles appear to be pretty much of the same size and shape, but of different degrees of transparency; some are reddish, others yellowish, and some transparent; they are of the shape of common pebbles, and the yellow much more bright and transparent than the red. The spangles are exceeding small, and appear to be thin flakes of talc. It is common in America, and is to be met with in some parts of England.

The Coarse Straw-coloured SAND, with heterogeneous particles, is very heavy, and of a pleasant pale yellow, with a considerable brightness, and pretty large white spangles. It looks very clear, and consists of regular particles, with regard to the size. It is sharp to the touch, and, when mixed with water, it subsides immediately, leaving it clear. When viewed through a microscope, the particles appear to be roundish, very bright and transparent, and the spangles are pretty large thick flakes of talc. It is common in the sand-pits about London.

The Coarse Sulphur-coloured SAND, with heterogeneous particles, is pretty heavy, and of a fine pale colour, somewhat between sulphur and saffron; it abounds with a great number of flat glittering spangles, which are broader than the other particles. It is harsh and rough to the touch, and when mixed with water subsides immediately, leaving it clear. When viewed through a microscope, the particles appear to be irregular in their size and shape, and many of them are not very transparent, though most of them are very bright. The shape is like that of common pebbles, and the spangles appear to be fine thin flakes of talc. It is common in Italy, and may be met with in Suffex.

The very Coarse, extremely Shining Yellow SAND, with heterogeneous particles, is very heavy, and of a fine yellow, though a little deeper than the ordinary pale gold colour. It glitters very much, and has also a great number of glittering spangles. The particles are regular and uniform, with regard to size, and it is rough to the touch; being shook in water it subsides in a moment, and yet leaves a little yellow muddiness therein. When viewed through a microscope, the particles appear to be very like small pebbles, and are all pretty transparent. The spangles are pretty numerous, but more white and less transparent than in many other of these Sands, because they are more thick. It may be met with on Hampstead Heath, and in many other parts of the kingdom.



The Fine Dusky Yellow SAND, with heterogeneous particles, is not heavy, and somewhat of a brownish yellow. It has a very dull look; but is mixed with glittering spangles, and the particles are very irregular with regard to their size; however, the spangles are very few, upon which account it has a more dead look than many others. It is soft to the touch, and subsides but slowly in water, leaving a yellow foulness therein. When viewed through a microscope, the particles appear to be of various sizes, with unequal surfaces, resembling small pebbles. The spangles consist of very thin talc. It is common in the sand-pits about London, as well as in many other places, and is generally mixed with ochreous clay, unless when found on the shores of rivers.

The Large SAND, of a yellow gold colour, with heterogeneous particles, is hard, coarse, and pretty heavy, and of a deep yellow colour, between saffron and gold. The particles are pretty bright and shining, but irregular, with regard to their size, and the white spangles which are large and bright are but few. It is harsh and rough to the touch, and subsides immediately in water, leaving a little yellow foulness therein. When viewed through a microscope, the particles appear in the shape of pebbles, are very transparent, and of a fine yellow: the spangles consist of flat fragments of selenites. It has been met with in Northamptonshire, Kent, and Suffex.

The very Coarse Saffron-coloured SAND, with heterogeneous particles, is pretty heavy, and of a fine strong saffron colour, or rather of a deep reddish yellow. The particles themselves are without brightness, but it is full of glittering spangles of talc. The particles are very irregular with regard to size, and they are pretty harsh to the touch; when mixed with water, they settle very slowly, leaving a yellow foulness therein. It is common in Germany, and has been found in Suffex and Leicesterhire.

The very Fine Dusky Saffron-coloured SAND, with heterogeneous particles, is not heavy; the colour is a dusky brownish yellow, with somewhat of a brightness; but the numerous spangles of talc make it appear greatly so. The particles are pretty regular, with regard to size, and the spangles are but little broader than they. It is harsh to the touch, settles slowly in water, and leaves a brownish muddiness therein. When viewed through a microscope, the particles appear to be small, and in the shape of pebbles, but not very transparent; the spangles appear to be thin flakes of talc. It is common in the sand-pits about Highgate and Hampstead, and in other parts of the kingdom.

The very Fine Brown Dull SAND consists of fine particles, which are not very heavy nor bright, inso-much that they appear like a heap of dust; however, they are pretty regular and uniform, with regard to size, and are harsh to the touch; in water it subsides but slowly, and leaves a muddiness therein. Through a microscope, the particles resemble small pebbles with unequal surfaces, and are pretty transparent, but not bright. It is met with in the sand-pits about Woolwich and Blackheath.

The very Coarse Shining Pale Brown SAND is one of the coarsest that is met with in this kingdom, though it is not remarkably heavy. The particles are pretty bright and sparkling, and regular with regard to size. It is very coarse and harsh to the touch, and mixed with water subsides immediately, leaving it clear. It is common about Woolwich.

The very Coarse Shining Dusky Purple SAND is very large and heavy, and of a deep purplish brown or chocolate colour, interspersed with white. The brightness is in a great measure owing to the white particles, and it is very rough to the touch; when

mixed with water it subsides almost immediately, leaving a somewhat yellow muddiness therein; through a microscope, the particles appear to be much of the same size and shape, being roundish. They are of two different colours, namely, chocolate colour, and white, which last are always smooth, and the former rough. It is to be met with near the Hot-Well at Bristol.

The Dull Brown Coarse SAND, with heterogeneous particles, is pretty heavy and of a pale brown, but very dull. The particles are irregular with regard to size and colour, some being much browner and coarser than the rest. When mixed with water, it subsides immediately, leaving it clear. When viewed through a microscope, the particles appear of different shapes and sizes, but chiefly like pebbles, and pretty bright and transparent. There are flatish fragments among them, which seem to be a sort of flint of different shapes, and there are others which are fragments of spar, upon which account it will ferment with aqua fortis. It is met with near Oxford.

The very Coarse Shining Pale Brown SAND, with heterogeneous particles, is large, pretty heavy, and of a faint pale brown colour; the particles are bright and pretty uniform, with regard to size. It is harsh to the touch, and mixed with water subsides immediately, leaving it clear. When viewed through a microscope, the particles appear to be of different shapes and colours, some being opaque and bluish, others transparent and inclining to yellow; but the greatest number are in the shape of pebbles with smooth surfaces, and of different degrees of a pale brown. Also there are many fragments of white brown transparent spar, upon which account it will ferment a little with aqua fortis.

Small Shining Greyish Black SAND is perfectly pure, and considerably fine and heavy; the colour is of a bright greyish black, and has a very agreeable look, the particles being uniform, both with regard to shape and size, and of a considerable brightness. It is harsh to the touch, and when mixed with water settles but slowly, though it does not leave the least foulness therein. When viewed through a microscope, it seems to be very bright and quite transparent, the particles appearing to be of an obtusely angular figure, and without any manner of colour. It is brought from Italy, where it is common.

The Fine very Shining Reddish Black SAND is clean, heavy and variegated with pale red, flesh-colour and white. The brightness is inherent in the particles it consists of, which are nearly of the same size, though different in shape, those that are black appearing roundish, and the others flat. It is sharp and harsh to the touch, and when mixed with water settles immediately, leaving it very clear. Viewed through a microscope, the particles appear like different gems; those that are black are almost opaque, with smooth surfaces and pretty round, but the others are all very bright and quite transparent, some being roundish and others flat. It has been hitherto found only in America, on the sides of hills and the shores of rivers.

The Coarse Dusky Green SAND, variegated with white, is pretty heavy, and of a deep dull green, with a considerable number of white particles. They are all nearly of the same size, but of different shapes. It is commonly harsh to the touch, and when mixed with water settles immediately, leaving it entirely clear. Viewed through a microscope, the white particles appear to be of two sorts, some of which are half transparent and cloudy, with obtuse angles, and others have sharper ridges, but are bright and quite without colour, besides which there are a few tinged with a faint yellow. The green particles, which are most numerous, are of a deep yellowish green, and



and of various shapes. It is brought from Virginia, where it is common.

The Fine Snow-white Stony GRIT is a perfectly pure and homogeneous substance, and small in proportion to its weight. Its particles are very bright and sparkling, and very regular in the size. It is harsh to the touch, subsides immediately in water, and leaves it quite clear. It ferments violently with aqua fortis; for which reason it seems to be composed of a very fine spar. It has been found in Mendip Hills in Somersetshire, in the perpendicular fissures of the strata of stone.

The Dull, Coarse, White, Stony GRIT, is much inferior to the former; for though it is perfectly pure, it is very hard and coarse. The colour is dull, there being little or no brightness; but the particles are very regular, with regard to their size. It is harsh to the touch, and in water subsides immediately, leaving it of a sort of milky colour. This also ferments briskly with aqua fortis, and therefore must consist of spar. It is met with in the same places as the former.

The Fine Cream-coloured Stony GRIT is pale, very heavy, and of a yellowish white or cream colour. It is very bright and sparkling, and consists of particles that are irregular with regard to size. It is harsh to the touch, and in water subsides immediately, leaving it a little milky. Viewed through a microscope, the particles appear to be of different shapes and sizes. They are all pretty transparent and bright, and seem to be without any colour. It consists of spar, for it will ferment violently with aqua fortis. It is found in one of the islands of the Archipelago.

The very Coarse Bright White Stony GRIT is very impure, and consists of two sorts of particles. It is very heavy, and of a dusky white colour, which however glitters in some places. The particles are all large, but very different in size, shape and colour. It is hard and harsh to the touch, and in water leaves a little milky foulness. Viewed through a microscope, it appears to be composed of a confused mixture of crystalline and sparry particles. It ferments strongly with aqua fortis, and a thin stratum of it has been found near Loughborough in Leicestershire.

The Very Coarse, White, Stony GRIT, with heterogeneous particles, is considerably heavy, and of a pure white, with black, yellow, and white flakes of talc. It is harsh and gritty to the touch, and subsides immediately in water, leaving a little whiteness therein. When viewed through a microscope, it appears to consist of large irregular particles, pretty transparent, and very white. The particles of talc have all very glossy surfaces, though of different kinds; but will not ferment with aqua fortis. It is common in Wales on the sea shore under cliffs.

The Dull, White, Fine, Stony GRIT is heavy, and of a dull whitish colour, with particles that appear to be much of the same size. It is rough to the touch, subsides quickly in water, and leaves a foulness therein. Viewed through a microscope, it appears to consist of opaque particles with rough surfaces, and of no certain shape. Among these there are a few loose specks, with surfaces as bright as crystal. It ferments violently with aqua fortis, and is entirely white when burnt. It is common in Derbyshire, and other places, where there are strata of stone.

The Dull, White, Coarse, Stony GRIT, is hard, pretty heavy, and void of brightness, and the particles are of different sizes and shapes. It is hard to the touch, and when mixed with water subsides immediately, leaving a muddiness therein. Viewed through a microscope, the particles appear to have rough surfaces, and are quite opaque; but there are

a few very small shining crystalline specks. It ferments very strongly with aqua fortis, and when burnt is entirely white. It is common in Yorkshire, and some other counties, where there are very large strata of it.

The Brownish, White, Fine, Stony GRIT resembles the former, is not very heavy, and void of all manner of brightness. The particles differ both in shape and size, and are not very rough or hard to the touch. When mixed with water, it leaves a muddiness therein after the subsidence. When viewed through a microscope, the particles seem to be of a loose spongy texture, and opaque, only there are a few shining specks in some parts. It is met with in the great stone quarry near Bath in the cavities of the stone, and ferments briskly with aqua fortis. It is also common in Liecestershire.

Glittering, Greyish, White, Fine, Stony GRIT, with heterogeneous particles, is pretty heavy, and of a pleasant pale greyish white. The particles are mixed with fine shining white spangles, and are different with regard to size, without the least brightness. The glittering proceeds from a mixture of a considerable quantity of talc. It is hard and rough to the touch, and when mixed with water subsides but slowly, leaving a whitish muddiness therein. When viewed through a microscope, the particles appear to be different, both with regard to size and shape, and besides the talc there are a few crystalline specks. It ferments violently with aqua fortis, and is common in the hills of Yorkshire.

Greenish, White, Stony GRIT, with heterogeneous particles, is pretty fine, very heavy, and of a dusky greenish white colour. The particles are different, both with regard to size and shape, without any brightness; but there is a mixture of broad flat particles of talc, which makes it glitter very much; it is not very rough to the touch, and when mixed with water subsides but slowly, leaving a greenish muddiness therein. When viewed through a microscope, it appears to consist of stony particles, which are different both with regard to their shape and size; but they are pretty transparent and bright, and the white talc appears in flakes. When burnt, it is of a pale brownish colour, and is met with in some parts of this kingdom.

The Coarse, Greenish, Grey, Dull, Stony GRIT, with a few heterogeneous particles, is very large, harsh, pretty heavy, and of a dull greenish grey colour, intermixed with a very few talky spangles, which are much less than the stony particles, that are alike both with regard to their size and shape. It feels pretty harsh and rough, and subsides immediately in water, leaving it quite clear. When viewed through a microscope, the whitish coarse particles, though not bright, are a little transparent, and there is here and there a crystalline speck, besides the particles of talc. It burns to a pale dusky red, and is common in Yorkshire and other places.

The GRIT, called the Puteolan powder by the antients, is a sort of greyish powder, composed of particles which are so exceeding small, that, when viewed through the best microscopes, no distinction appears among them. It looks perfectly dull of itself, for what brightness there is may be probably owing to the talky particles. When mixed with water, it subsides very slowly, leaving a great whitish muddiness therein. When mixed with salt water, it soon dries into a hard stony mass, which will not afterwards easily dissolve when mixed with common water. It was used by the antients as a mixture for their cements of buildings near the sea. It is now known by the name of the Pozzolane, and is an ingredient of hard plasters, in several parts of France and Italy.

Fine, Pale Reddish Stony GRIT is heavy, and of a very



very pale whitish or brownish red; it is very bright and sparkling, and even to a greater degree than many of the sands. It is harsh and rough to the touch, and mixed with water subsides immediately, leaving it entirely clear. The particles, when viewed through a microscope, appear to be of irregular shapes, some of which are of a pale red, others brownish, and others without any colour at all. It ferments slightly with aqua fortis, and undergoes little change in the fire. It has been found near Bristol.

The Pale Red, Shining, Coarse, Stony GRIT, is pretty heavy, with particles that are irregular, with regard to their size, and remarkably bright. It is very harsh to the touch, and immediately subsides in water, leaving it extremely clear. When viewed through a microscope, the particles appear to be crystalline and quite transparent, but of irregular shapes; some of them are without colour, and others are of a very pale red. It will not ferment with aqua fortis, nor will the fire produce any great change. It is found on the coast of Fife, in Scotland.

The Greyish Red, Coarse, Shining, Stony GRIT, is very heavy, and the particles are of various shapes and sizes, many of which are very bright and shining, and others quite opaque. It is very harsh and hard to the touch, and immediately subsides in water, leaving it very clear. When viewed through a microscope, some of the particles appear to be white, and very opaque; others are without colour and transparent, and others again are stained with a pale red. It ferments strongly with aqua fortis, and burns to a fine red. It is found on the shores of the island of Minorca.

The very Coarse Greenish Red Dull GRIT is very heavy, and of a fine flesh colour, variegated with green. The particles are pretty uniform and regular, with regard to their size, and they are of an irregular angular shape. It is very hard to the touch, and subsides immediately in water, leaving it clear. Through a microscope, some of the particles appear to be whitish, others of a pale red, and others of a fine light green; but they are all pretty transparent. It is found on the shores of the Mediterranean sea.

The Fine Shining GRIT, of the colour of rusty iron, but darker, is full of spangles that appear bright and glittering, which are not talc but crystalline, and without any colour. They are much of the same size, and extremely harsh to the touch; they subside very soon in water, leaving it extremely clear. Through a microscope, the particles appear to be of different colours; for some are whitish, others yellowish and semi-transparent, and others without any colour, and as bright as crystal; but the greatest number are brown. It is found near Lisbon in Portugal.

Fine Red Stony GRIT, with heterogeneous particles, is very heavy, and of an agreeable red colour, with a whitish cast. The stoney particles are a little bright, but the mixture of glittering flat spangles renders the mass extremely so. All the particles seem to be uniform with regard to their size, and are very rough to the touch; in water they subside immediately, leaving it quite clear. Through a microscope, the particles of this grit appear to be transparent crystal, of a pale red, and all somewhat angular, interspersed with very bright transparent particles of brownish white talc. It is found on the shores of the island of Minorca.

The Coarse Red Variegated GRIT, with heterogeneous particles, is very bright and heavy, though light and coarse; the colour is variegated, though the red predominates, and the particles of that part are very bright and sparkling; besides these, there are many white crystalline fragments, and a vast

variety of yellow and black flakes of talc, all which glitter very much, and give the whole a pretty pleasing appearance. They are all nearly of the same size, feel extremely harsh and rough, and in water subside immediately, leaving it clear. It is found on the coast of Scotland.

The very Coarse, extremely Shining, Flesh-coloured, Variegated GRIT, with heterogeneous particles, is more beautiful than the former, and pretty heavy. The flesh colour or pale red is very lively, and variegated with black and brown particles of talc, besides some that are white and crystalline; and all the particles in general are very bright and glittering, but irregular with regard to their size. It is hard and harsh to the touch, and subsides immediately in water, leaving it clear. When viewed through a microscope, the particles all appear to be large and coarse, but of very different shapes and colours, though some are reddish and yellowish, others without colour, and others again, that are blackish and reddish, or opaque. The talky spangles are brown and black, for there are none that are white.

The Fine Brownish Red Variegated GRIT, with heterogeneous particles, is not so glittering as the former; but it is very fine, heavy, and of a faint brownish red, variegated with white, black and yellow. The particles are all bright and shining, and much of the same size. It is sharp to the touch, and in water subsides but slowly; however, it leaves it clear. The particles, when viewed through a microscope, appear to be of irregular shapes, some of which seem to be spar, are semi-transparent, and whitish, reddish, or brownish; others are crystalline without colour, though some are reddish or brownish and very bright, and others opaque and stony, and of a blackish or reddish colour. Those with the talky flakes make a very agreeable appearance, for they are of different colours, as white, yellow, and black. It ferments a little with aqua fortis, but undergoes no change in the fire.

The Fine Flesh-coloured Variegated GRIT, with heterogeneous particles, is not so beautiful as any of the former, though it is very fine, pretty heavy, of a bright flesh-colour, and very glittering. The particles are all nearly of the same size, and there is little variegation of white and black. It is sharp to the touch, and subsides immediately in water, leaving it clear. When viewed through a microscope, the particles appear to be of very irregular shapes, and some are white, others reddish, and others without any colour at all. They are not all equally transparent, but the greatest part of them are very bright, and there is a mixture of flaky spangles of talc, of white, brown, and black colours, with a few blackish stony particles. It burns to a paler colour.

The extremely Pale, Whitish Red, Variegated GRIT, with heterogeneous particles, is not so finely coloured as some of the former; but it is extremely fine, very heavy, and of a pale whitish flesh-colour. It is variegated with many black spangles, the particles are all very bright and glittering, and are nearly of the same size. The talky spangles are black, and remarkably thin. It is sharp to the touch; and, though it subsides slowly in water, it leaves it very clear. When viewed through a microscope, all the particles appear to be transparent, except a few that are black, and the fire turns it to a grey colour. This and the four former are common on the shores of islands in the northern parts of the world.

The Brownish Red Coarse Stony GRIT, with heterogeneous particles, is considerably heavy, and of a fine pale flesh-colour, variegated with brown, and there are a few glittering plates of white talc. The particles are regular with regard to their size, and pretty bright and shining, which render the whole



whole mass very glittering. It is sharp and harsh to the touch, and subsides immediately in water, leaving a little muddiness therein. Through a microscope, the particles appear of different shapes; but most of them are flattish and bright, though not very transparent. Some are of different degrees of flesh-colour, others of no colour at all, and there are also brown particles, that are more transparent than the rest. There are a few spangles of white talc, which are very thin, and smaller than the other particles. It burns to a little pale red. It is met with on the shores of the Red Sea.

The very Coarse Shining Blackish Flesh-coloured GRIT, with heterogeneous particles, is remarkably heavy, and of a mixed colour, between pale red and black, and the particles are bright and shining, besides which there are a few black flakes of talc, but not so large as the other particles, though they are of different sizes. They are very hard to the touch, and subside immediately in water, leaving it clear. Through a microscope, the particles appear of various colours, shapes and sizes; for some are white, others of a pale red, and a great number are black, and though they are not transparent, they shine more than the rest. It does not undergo any change in the fire. It is found on the shores of the islands of Sicily.

The very Coarse Shining Reddish Green Stony GRIT, with heterogeneous particles, is considerably heavy, and a reddish green, or rather of a greenish red. The particles are partly green and partly red, intermixed with many that are white, and all together are bright and sparkling: there are also a few spangles of greenish white talc. All the particles are nearly of the same size, and are very hard and sharp to the touch; they subside immediately in water, leaving a reddish muddiness therein. It is found on the shores of the Mediterranean sea.

The CRYSOCOLLA of the ancients is a beautiful green, though dull Grit; it is somewhat coarse, moderately heavy, and of an exceeding lively and agreeable green, with very uniform particles, which are nearly of the same size, but of little brightness. It is not very harsh to the touch, and subsides immediately in water, leaving it quite clear. Through a microscope the particles appear to be pure, and in angular figures, generally approaching to a rhomboidal form. It ferments strongly with aqua fortis, and tinges it with a bluish green. It is found on the shores of New England, and is taken to be green sand; it has also been brought from the shores of the Red Sea. It is used by goldsmiths for the foldering gold, and by painters as a colour. That is looked upon to be the best, which comes nearest the colour of an emerald.

The Fine Shining Pale Green GRIT is very heavy, and variegated with white; it is very bright and shining, the particles are regular in their size, and it is harsh and sharp to the touch; it subsides immediately in water, leaving it entirely clear. It is found upon the shores of the Red Sea.

The Shining Gold-coloured GRIT, with heterogeneous particles, is light in comparison of many others. The flakes are of different sizes, and it is softer to the touch than any other kind; it subsides slowly in water, and leaves a whitish yellow muddiness therein. Through a microscope, the stony particles appear to be reddish, whitish, and seemingly transparent. It is found in Virginia, Germany, France, and England.

The very Hard Fine Black GRIT, variegated with white, is the hardest, heaviest, and brightest of all the Grits, and is of a fine jet black colour, with a few specks of white. It consists of particles nearly of the same size, and is exceeding hard to the touch; it subsides immediately in water, and leaves it entirely clear. Through a microscope, the particles

appear to be all angular, of which some are whitish, and others greyish, but both are very transparent; yet those of a jet black, which are most numerous, are entirely opaque. It is met with in France.

The Fine Black and White GRIT, with heterogeneous particles, is pretty heavy, and the principal particles are bright and shining, but they are rendered more so by the mixture of fine white flakes of talc; it is harsh and sharp to the touch, and subsides very soon in water, leaving it quite clear. Through a microscope, the black particles appear to be opaque, and there are a great many transparent, without any colour, and exceeding bright; the flakes of talc are also transparent. It is brought from the shores of the Mediterranean sea.

The very Coarse Black and White GRIT, with heterogeneous particles, is extremely heavy, and its particles seem to be all nearly of the same size; the greatest part seem to be coarse and dull, but there are a few that are bright; however, the quantity of talc makes it glitter pretty much; for they are white and glossy. It is rough to the touch, and subsides immediately in water, leaving it very clear. Through a microscope, it seems to consist of a great number of white semi-transparent particles, of which there are some as clear as crystal, and very bright, besides many of coarse white talc, and a great many others that are black and opaque. When burnt it is of a flesh colour, with black and white spots. It is found in Wales.

The Shining GRIT, of a rusty black colour, with heterogeneous particles, is considerably fine and heavy, but entirely dull of itself, though the great number of black flat shining particles make it shine very much. It is harsh and rough to the touch, and settles immediately in water, leaving it entirely clear. Through a microscope, it appears to consist of different particles; and those without colour, as well as the yellowish and reddish, are like small pebbles; these are bright and pretty transparent, besides which there are many others of uncertain shapes, and quite opaque: these seem to be fragments of stones of different kinds; and there are a great many that are dusky, with somewhat of a reddish colour, supposed to be pieces of iron ore. Besides these, there are multitudes of spangles of different shapes and sizes, which are all very bright, and are taken for fragments of lead ore. In the fire it becomes blacker, and is known in England by the name of black writing sand.

The Coarse Sparkling Brownish Black GRIT is much like the former, but is more coarse, and remarkably heavy. It owes its sparkling to flat shining particles like the former, though they are not so many in number. It is very sharp to the touch, and subsides in water immediately, leaving a little blackness therein. Through a microscope, the particles appear to be various, of different shapes and figures, but nearly of the same size. They are partly fragments of stone, and partly iron and lead ores; but they are not so bright as in the former, they having smaller surfaces. The iron ore is discovered in this by means of a loadstone, as well as in the former. It is common on the shores of Wales, and serves for the same purpose as the preceding.

The Fine Brownish Black Sparkling GRIT is pretty fine, and remarkably heavy, with an agreeable bluish black bright colour. The particles are of various shapes and sizes, and it is pretty harsh to the touch; it subsides immediately in water, and leaves it quite clear. Through a microscope, the particles appear to be of various colours; for some are reddish, some greenish, and others blackish, mixed among a vast number of particles of various sizes and shapes, but all of a bluish black, with glossy surfaces. It ferments slightly with aqua fortis, which is probably owing to the sparry mat-



ter contained therein. It is common on the shores of Wales.

#### C H A P. XXXIV.

#### Of MARCHASITES and PYRITES, or FIRE STONES.

THE generality of Authors think Marchasites and Pyrites to be the same substance, and others distinguish them, making two different species thereof. Boet observes, there are several kinds of Pyrites, and that all stones, that strike fire properly, deserve that name. Some are bright like silver, others consist of several coats, others are like dice. Some are like red marble, and shine with a metal-line splendour, others are purple, quadrangular and transparent, and others again are spongy and shining or pumiceous. Some have eight angles, others have twelve, others are like bismuth, and others again are tinged with a gold colour, from whence they take the name of Marchasites. Some are of a copper-colour; others are of various colours and forms, and others are mixed with stones. Among these, some will melt in the fire, and are added to metals instead of lead, to render them more fusible, and when they are broken they shine like sugar-candy. He adds to this, that there are stones called Pyrites, which will not strike fire with steel, and these he thinks ought not to be placed in that class. Among the Marchasites so called by some there are,

The Silver-coloured MARCHASITE, which is of a very firm and compact texture, and remarkably heavy. It is found making strata of itself, which though very broad are thin, being from three inches to a foot in thickness. Sometimes there are pieces found by themselves, and in general they have a very irregular and unequal surface, they being made up of great numbers of irregular flakes, and of various sizes; they being bent, undulated, and sometimes infold each other. However, these plates are not at all distinguishable by the naked eye, but seem to constitute one solid mass. The colour resembles that of silver, but is more glittering. It readily strikes fire with steel, but will not ferment with aqua fortis; and when put into the fire it cracks and breaks, emitting a blue flame with the smell of brimstone. After it has burnt a considerable time, it turns to a deep red. Sometimes this Marchasite is mixed with lead ore, sometimes with that of tin, and very often a dusky brown ferruginous substance. It is found in great plenty in lead and tin mines.

The gold-coloured MARCHASITE is more glittering than the former, but not so compact, though pretty heavy. It is commonly found in thin strata, and sometimes in pieces. It seems to be composed of flat flakes, not unlike great numbers of irregular fragments of leaf gold, placed together without the least order. However, some parts of this Marchasite are more loose and open than others, though it is all in its natural shape of a deep yellow gold-colour; however, it is sometimes paler, sometimes deeper, and at other times will reflect all the colours of the rainbow. It will not strike fire with steel so readily as the former, nor will it ferment with aqua fortis. When thrown into the fire, it will slowly emit a blue flame from all parts of its surface. It is plenty in Germany, particularly in Hartz forest, and has been met with in England, but not so often as in the former.

Heavy white MARCHASITE is very firm and solid, and more heavy than the other two. It is often found in strata by itself, and sometimes in detached pieces; but is more commonly met with in the cavities of other strata, of the breadth of several

yards. It has a smoother surface than the others, and is more uniform in its composition; though, if it be carefully examined, it seems to consist of undulated flakes laid closely upon each other. It strikes fire with steel; it will not ferment with aqua fortis, and when put into the fire burns pretty briskly, emitting a blue flame, with the smell of brimstone. It is found in Devonshire, Cornwall, and some other counties. These are all the Marchasites properly so called, taken notice of by authors.

The Flat Pyrites or FIRE-STONE, with a rough coat, can hardly be distinguished from other Stones by its external appearance. It is pretty firm and hard, as well as heavy, and is of no certain size, being found from one inch to ten in diameter. It is always flat and thin, and has very unequal and irregular edges. When it is about four inches long, it is half an inch thick, and requires a strong blow to break it in pieces. When broken its texture seems to be regular and uniform, consisting of one homogeneous mass, of a dusky brownish green colour, surrounded with a coat of a dusky ferruginous substance, which is rough and beset with small pebbles of different shapes and sizes, though generally no bigger than grains of sand. It is always of the colour of rusty iron, and is thicker in some than in others. It will strike fire with steel, but not ferment with aqua fortis; and in the fire it emits a blue flame which soon goes out, and when sufficiently burnt it turns to a deep purple. It is found in gravel-pits all over the kingdom.

The Round PYRITES, with a cracked coat, is coarser than the former, it being composed of visible grit. It is very heavy, and of various sizes, from half an inch to twelve in diameter, and requires a strong blow to break it. The colour is pale, with a mixture of dull whitish green, and a dusky brownish cloud. The outer coat or crust is of a brownish yellow, and of different thickness; the surface is divided by shallow cracks, and after it has been for some time in the air, they become deeper. It readily strikes fire with steel, and in the fire emits a strong blue flame, and last of all calcines to a purple powder. It is common in the chalk-pits of Kent, and many other places.

The Flat PYRITES, with a very thick whitish brown crust, is extremely hard and firm, though moderately heavy. It is commonly flat and round, or oval, and its usual size is two inches and a half in length, two in breadth, and one in depth. The surface is rough, it being full of small tubercles, and it has the look of a lump of brownish clay; it requires a smart blow to break it, and when broken, a nucleus is found of the same shape with the whole stone. This is very compact, firm, and hard, and of a deep dusky green. The nucleus will strike fire with steel, and burns to a red; but the crust itself turns to a pale brick colour. It was found in a clay-pit near the end of Gray's-Inn-Lane, and very probably may be met with in many other places.

The Green PYRITES, without a crust, is met with in a great variety of different shapes. It is of a hard firm close texture, and very heavy, and is found from half an inch to ten inches and upwards in length. Sometimes it is in the shape of a common pebble, but it is more generally flat, with an uneven undulated surface, and seems to consist of many plates laid one upon another. It is extremely hard before it has been exposed long to the air, and is, both within and without, of a pale silvery green. It readily strikes fire with steel, but will not ferment with aqua fortis; it readily cracks and breaks in the fire, emitting a fine deep blue flame, and turning at last to a florid red. It is very common in all parts of England, particularly in strata of blue clay.

The PYRITES, resembling a bunch of grapes without



without a coat, is of a firm hard structure, and remarkably heavy. It is commonly small, and of a longish form, though sometimes round, and many pounds in weight. It is most commonly without any crust, and requires a strong blow to break it. When broken, it appears to be a kind of a metallic body. It is most commonly of a very pale green, though sometimes deeper, and the surface is always covered with tubercles of various sizes, so as to have a distant resemblance of a bunch of grapes. It strikes fire readily with steel, emits a blue flame in the fire, and soon falls to pieces; but at length turns to a beautiful purple. It is common in many parts of England, and when it has been long exposed to the air, has often a thin coat of a rusty colour.

The Round PYRITES, with a streaked structure, and an irregular surface, is very heavy, and is usually found in a roundish shape. The general size is from four to six ounces in weight, though there are some of two or three pounds. The surface is irregular, and sometimes beset with flattish tubercles, and sometimes raised in ridges, on account of their being placed in distinct rows, which meet in various angles. It is pretty hard, and when broken appears to be of a streaked texture, and the streaks run from the centre to the circumference. It is of a whitish green within, is covered with a brown crust, and is very bright and glittering when just broken. It strikes fire with steel, and burns to a purple powder. It is common in chalk-pits.

The Round PYRITES, with angular tubercles, is remarkably heavy, and is found from an ounce to a pound or upwards in weight. It is generally roundish, and the surface is remarkably rough. It is of a rusty colour, and is covered over with short quadrangular pyramids, which are broad at their basis, and blunt at their points, commonly standing very upright and close to each other. It cannot be broken without a strong blow; but when it is in pieces, these are found to be streaked, and of a greenish colour, with some small mixture of yellow. It strikes fire with steel, and will flame soon in the fire, with the smell of brimstone, and bursts to pieces; after which it calcines to a fine deep purple. It is common in England in the strata of chalk.

The Silver-coloured Round PYRITES, with a smooth surface, is of a pretty firm texture, and remarkably heavy. It is commonly round, and the usual size is about an inch and a half in diameter; but it is sometimes met with to the weight of two pounds. It is always without tubercles and ridges, and the surface is of the same colour as the inside, though not quite so bright. It breaks with a small blow, and when broken appears to be of a streaked texture, of a beautiful silvery green colour, and the streaks run from the centre to the circumference. It strikes fire with steel, and in the fire emits a blue flame, with a strong smell of brimstone, after which it bursts and calcines to a deep purple powder.

The PYRITES, with a foliaceous surface, is of a very firm though uneven texture, but very heavy; it is of various shapes, but commonly round. It is of different sizes, but generally large, though those of six or eight inches are commonly round. It is harder than most other stones of this kind, and when broken appears to be of a streaked texture, and the extremities of the surface are seen in rows of thin leafy plates, which cover the whole. They generally lean one way, but are of unequal thicknesses, and sometimes notched at the end. The colour is a dusky green, which when broken is very bright and glittering. In the fire it emits a deep blue flame and bursts, after which it calcines to a purple powder. It is found at Goslar in Saxony, and in Hartz forest, and sometimes in England, particularly Mendip hills, Derbyshire, and Cornwall.

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The PYRITES, with a smooth glossy surface, is of a very firm coarse regular substance, and remarkably heavy. It is of a very particular shape, being always more or less hollow, and in various forms, often like pebbles, but more particularly rugged and knobby. The common size is five or six inches in diameter, and the surface is so glossy, that even the tubercles thereon appear to be so. It is very hard, and when broken appears to be streaked with irregular cavities, and the streaks are more narrow than in other stones of this kind. On the inside they commonly terminate in broad plates, nearly of a square figure, and are disposed in rows. The general colour is greenish; but if it is broken where these plates are, it is commonly of a bright beautiful yellow. It emits a blue flame like the rest, and calcines to a fine red.

The Large Foliateous PYRITES, in the shape of a cube, is of so regular a figure, that it has by many been thought to have been the effect of art. It is of a firm regular structure, very heavy, and is commonly found about one third of an inch in diameter. All sides are perfectly smooth, and it breaks in all directions; for it consists of plates in the direction of all the surface. It is glossy on the inside when just broken, and seems to be composed of plates like talc. It is of a fine whitish green colour, with a small mixture of yellow. In the fire it emits a deep blue flame, with a strong smell of brimstone, and calcines to a deep purple. It is found in Germany, Hungary, and the East Indies.

The Small Solid PYRITES, in the shape of a cube, is not unlike the former, it being firm and hard, and very heavy. The shape is regular, and the size is commonly about an eighth of an inch in diameter. It is perfectly smooth on every side, and when broken is very bright and glossy. Its colour is commonly a pale yellowish green, though in those that are large it is somewhat of a rust colour. It cracks and bursts in the fire, emitting a deep blue flame, and at last calcines to a fine red. It is frequently to be met with in the northern parts of England, and many other countries. It is here found in common black slate, but in Germany about the earth on the mountains.

The Bright PYRITES, with eight sides, is very firm and compact, of a pretty even texture, and very heavy. It is always composed of eight triangular planes, though it is subject to some varieties. Its most perfect shape is when two pyramids are placed evenly one against the other; but they are more commonly set uneven and slanting, and their planes are very irregular, with regard to their size. It is from the bigness of a large pin-head to that of a walnut; they are naturally smooth, and of the colour of polished iron. When broken the pieces appear very bright and sparkling, and often much paler than the outer surface. They seem to be composed of irregular thin undulated plates, laid more closely together than in the marchasites. In the fire it cracks and bursts, emitting a blue flame, with the smell of brimstone, and at last calcines to a deep purple. It is found in Cornwall, and is very common in North America.

The Hard Shining PYRITES, with twelve sides, when perfect, is extremely beautiful, but is seldom met with in that state. It is pretty hard, of a regular texture, and very heavy. It is subject to great irregularities; but often wants one or more of its sides, and has commonly other bodies of its own substance sticking fast to it. It is of various sizes, it being from one inch to four in diameter; but is more frequently about the third part of an inch. The surface is smooth and shining, and generally of a pale yellow, sometimes of the colour of rusty iron, and sometimes of polished steel. When broken it appears to be of a foliaceous substance, and to consist



of very thin plates irregularly placed, and may often be distinguished by the naked eye. In the fire it emits a blue flame, with the smell of brimstone, and calcines to a bluish purple. It is found in Cornwall, but is more common in Germany, as well as in the East and West Indies. It is observable, that all these kinds of stones strike fire with steel, and will not ferment with aqua fortis.

## C H A P. XXXV.

## Of FOSSILE PETRIFIED BODIES.

**B**EFORE we come to particulars, it will not be improper to take notice of petrifications in general, some of which are performed, as it were, within our sight, and therefore are most easy to be understood. The first of these is the stalactites, which is a kind of cylinder formed on the roofs of some caves and grottos, and which has been already taken notice of in its proper place. This is evidently brought to pass by means of the water, which carries with it very fine sand, that by length of time increases to different sizes, and forms the different layers which are successively produced one over another.

Another kind of petrification, which is well known, are the crusts of stone, which the water of some springs fixes by little and little to the pipe through which it passes; for these are almost every where to be seen. From these it plainly appears, that the matter of the petrifications, let their nature be what they will, is driven by water to the sides of the pipe in small particles, which being applied to each other without any regularity, forces the water itself to turn from the centre of its course, to make a passage for itself; because the stony matter is applied as it were by chance.

Another sort of petrification, also very well known, is that of the pieces of wood, shells, and other substances, that are petrified in the bowels of the earth, or in springs, without losing their shape, or distinguishing marks by which they are commonly known. These may be distinguished into three kinds; that made in plates or layers, that done by pellets or balls, and that by penetration.

The substances by which these are brought about, are water, salt, oily juice, sand, mud, and clay. The water seldom penetrates the substance of stones to no purpose, but carries with it and mixes the materials of which it is composed; much in the same manner as the masons make use of water wherewith to blend and intimately unite the materials of which they make mortar or cement, that grows hard in proportion as the water flies off.

The three different petrifications are performed likewise by minute masses or lumps, and a very fine cement. The masses to be incorporated are the sand, clay, and loam: the most durable cements are the salts, and several kinds of bitumen. Sometimes the salts, intermingled with the clay, serve as a cement for the sand; at other times, the mass is composed of clay, or loam alone, without any intermixture. From the different degrees of these several bodies, thus differently intermixed, proceed a vast variety of productions.

To the first kind of petrification we may refer talcs, slates, plumous alum, and plaster. As for crystal, it is nothing but a heap of sand, perhaps in a pyramidal or triangular shape, which the water applies successively one upon another, uniting them together with a little salt, and very fine mud; this is the more probable, because when crystal is decomposed in the fire, there remains nothing but calcined sand, earth, and a little salt. We need not wonder that crystal should be thus formed into a transparent mass, because several sorts of white sand,

viewed through a microscope, appear to be nothing else but true white crystal. The earth or mud, that is joined thereto, only hinders them from shining like a diamond.

It is easy to imagine, that a fall of water may bring into any place a layer of sand and blackish earth, and that a second may throw another upon the former, and so on, inasmuch that, in length of time, slate may be produced of different thicknesses. In the same manner different substances may form talc, plumous alum, and plaster.

The second sort of petrification is that, which is performed by small bullets or balls, and often by bunches composed thereof. It is probably by this means that gems receive their formation; because many of them are found in the chinks and cavities of certain rocks, where the water can bring nothing with it but sand, salts and a little bitumen, and by chance some metalline particles. These small congelations of matter, coming to sink and harden by degrees, may carry along with them the very fine particles they meet with. The generation of irregular flints, and all other stones that will strike fire with steel, seems to be the same as that of gems; for the water meeting in its course certain cavities more or less wide in marl, chalk or clay, that are in rocks, there deposits the salts, the oily fluids, and the fine sand with which it is imbedded. This water afterwards evaporating, the sand, and every thing that is introduced within the cavity, becomes hard as in a mould, and forms a mass which takes the same figure. When fine sand is the principal ingredient, the concretion is more or less transparent and hard, as are all sorts of gems. The colours are dull, variegated, or marbled with veins, in proportion to the different mixtures of the substance of which they are formed. When there is a great deal of salt or sulphur, which are well known to contain particles that strike the nose and yield fire, then the stone will have a strong smell of sulphur when it is broken or struck, and will sparkle when it meets the blows of another stone as hard as itself, or when it is struck with the steel or hammer, that by its extraordinary hardness discomposes the pores wherein the particles of fire are lodged. These sorts of stones very evidently contain a great deal of fire, and therefore they might be supposed by some to be electrical, and yet it is plain they have no such quality, which may be owing to the earthy particles in which the fire lies hid, and which may prevent the effects of rubbing, in the same manner as a lock of wool placed against a glass, or when tied to the string of a musical instrument, prevents the vibrations, and consequently the sound.

There are a great many flints and flinty stones that are exactly round or oval, or approaching thereto, and of all sizes, which seem to be composed of, or form small pellets or plates, by means of a nucleus which is the basis of the whole. When the water is loaded with a small bit of marl, or some small stone, as it repasses through this small mass, it will fill up its pores or inequalities with the clay or other particles contained therein, and will bestow upon it a smooth and pretty regular surface. If this is repeated several times by the application of the water to the mass, it will always leave a small layer or coat of sand before it flies off. These circular layers or coats growing hard, by the evaporation of the water, will form a small arch, which will grow still stronger and stronger, by the successive application of several other layers or coats. The whole will grow more thick in proportion to the number of times that the water returns, and deposits fresh matter. It may so happen that the nucleus of chalk, marl, stone, or clay, which has been as it were the foundation of the first arch, being rendered hot by some external means, all the moisture will evaporate and



and diminish the size. By these means it may often come to pass, that there may be a nucleus in the middle of the stone, as we often find by experience; which may be sometimes chalk, sometimes common earth, or other substances, quite different from that of the stone; so that at length by shaking the stone it may be easily found by the rattling, that some substance is contained therein. Thus the formation of round and oval stones becomes much the same as that of certain stones which are known by the name of Bezoars, and which are found in the bellies of several animals, both in the East and West Indies, and to which great virtues are attributed.

Some of these stones, that have a cavity in the middle, often contain a hard substance, or another stone, which may be easily known from the noise it makes when shaken; and this is commonly called by the name of the Eagle Stone, to which most extraordinary qualities have falsely been attributed.

The third manner of petrification is what is called by some penetration, and this is the most common; thus a large bed of sand, clay, or other matter, may be petrified by the salts and other particles where-with the water is imbued when it sinks therein. The water will carry with it all the fine salts it has dissolved and taken up by the way, as well as the exceeding fine earthy particles which have remained therein. This water will readily pass, as well as every thing it contains, through a bed of sand, that is too full of pores to stop it; but it will fill by degrees all the interstices of more compact sand, and will closely unite all the particles; and by this means we may understand the formation of what we commonly call free-stone. A bed of earth or of sand will be changed into a stone more or less hard in proportion to the quantity of clay or sand contained therein. Marl and potters clay thus mixed with sand will be changed into marble, whose ground may be either red, green, or black, according to the nature of the petrified bed. Perhaps the ground of any marble may be nothing but very fine sand, into which the water has penetrated, and carried at many thousand different times the fine particles of marl and potters clay, and which in process of time may obtain the hardness in which they are found; and consequently their natures, colours, mixtures, and clouds, may vary to infinity. If the potters clay has been dried and cracked by some subterraneous heat, the fine sand, or marl, or other substances which are carried by the water, and deposited in the chinks or cracks, may produce veins of all colours, and of all shapes. Likewise, when there are particles of gold, or any other metal, that are fine enough to be dragged along by the water, they may serve to augment the richness of these variegations. The drops of oily fluids, which the water carries along with it, may expand and form a multitude of small spots, which may be round when they are at liberty, or oval when they are a little confined on each side; or, in short, they may be angular, or of any other shape, according to the impediments they meet with. All the winding veins, on the sides of which we sometimes see rows of small specks of gold, or other metals, extremely fine, serve to shew very evidently the progress that the water has made; for when it happens to be stopped, and obliged to turn, it penetrates wherever it can, and so produces very irregular variegations. The particles which the water contains, being naturally a little more heavy than itself, must needs be deposited in time, and stopping by the way, must penetrate the very first cracks or other cavities that they meet with. We may compare the formation of a marble, or other stone, to that of cloth or tapestry; for the body of the sand or clay, which is capable of penetration by water, may be compared to that

which weavers call the warp, and the water to the shuttle, which passes across the other without stopping. The fine sand, the particles of common clay, the colours of potters clay, the fine threads or small leaves of metallic substances, may all together be compared to the woof, which is introduced into the body of the work, and which fills it by little and little.

However, it sometimes happens, that there are thin plates or layers of clay between the different beds or strata of stone, and which are free from any mixture at all; from whence it appears, that they have hindered the progress of the water, for they only served to sustain, and could not be penetrated by it. Perhaps it may be thought a wonder, why there should be any stratum of stone or marble under this clay, since the water could not get through it; but this will soon cease, when we consider, that many parts of the clay may be very thin and full of cracks, and consequently will admit the water to pass very freely through it. All the water with its contents may run over the clay, and may be shed, at the extremity of this layer, into the bed which lies beneath; and it has been found by experience, that many rocks of an enormous size will not prevent the water from passing through their bowels, and falling into beds of sand that are placed underneath.

That which the water performs, by the penetration of the different strata contained in the earth, it brings about in some degree with regard to pieces of wood, bones, and other substances which it enters into; and which affords us a reason or method of explanation of all the different petrifications, though never so odd, which are to be met with in all parts of the world. We cannot determine whether there has ever been an universal earthquake or not, which has changed its primitive form; for we find several sorts of animals, and sometimes mankind, in small islands at a vast distance from the main land, which can hardly be accounted for, but from some extraordinary cause, that has produced great irregularities in the face of the earth, making that to be a sea, which was dry land before, and raising up mountains out of the bosom of the deep; especially since we find, from some such change, that there are a vast number of marine bodies at a great distance from the sea, and a great deal higher than its surface. However, this is certain, that many substances, which seem to have been proper only to the sea, are now found in the bowels of the earth; and which have perhaps been petrified by degrees, by the insinuation of water, salts, and exceeding small crystalline or stony particles, proper to fill up their pores, without alteration of their shape. To this all the productions which some have looked upon as *lusus nature*, or sports of nature, are evidently owing. Besides the bones of crocodiles, the skeletons of sea horses, the entire bodies of petrified fish, there are almost every where found sea shells of all kinds, and all sorts of the parts of sea animals, converted into stone. Some are very wonderful with regard to their situation, and others as to the oddness of their shapes. However, some are of opinion, that if these changes have been in reality produced by earthquakes, it will not from thence follow we should find them converted into stone; but this may be easily accounted for, if we reflect a little on what has just been said: for their situation is no more difficult to be comprehended than that of flints, which are generated in the middle of other substances; for, though they undoubtedly were in their natural state before the alterations were made, yet it is easy to conceive in what manner they have been petrified since that time. These petrifications have had different names bestowed upon them by naturalists, and therefore it will be necessary to give a more distinct account thereof.



thereof. They are principally of two kinds, that is, animal and vegetable substances; some of which have remained in the earth a vast number of years without any great alteration, and others have been covered with or turned into stone; however, they all come under the denomination of Fossils.

With regard to trees, there have many been found buried under ground in many parts of the world, and particularly in England; as on the coast of Suffolk near Dunwich, in the fens of Lincolnshire and Yorkshire; and more particularly in the isle of Axholm, which is made by rivers, and lies between Nottinghamshire, Lincolnshire, and Yorkshire; as also on the coast of Pembrokeshire in Wales. These have not only been found near the sea, but in inland countries at the depth of ten or twenty fells.

In England, there are some that lie at a distance from the sea, as in Chatmoos in Lancashire, several parts of Yorkshire and Cheshire, as well as in Staffordshire. The places in this last county where they are found are Laynton, and the old Pewit Pool in the parish of Norbury; Shebben Pool, in the parish of High Offley; the mosses near Eardley, in the parish of Audley, and near the town of Betley; all which lie in the high country of the moor lands. They are found still farther from the sea in Cranmoor near Wrottesly; in Rotten Meadow under Wednesbury Hall; on Dorley Common in the parish of Gnosaf; in a place called Peat-Moor, and in the moors of Handsworth; none of which are less than thirty, and some are above fifty miles from the sea. Some will have these to have been originally formed in the earth, especially because they resemble firs, of which sort none ever grew naturally in England, if we may believe the account that Cæsar gives in his Commentaries; but his authority is not always sufficient. However, this appears plainly to be a mistake; because many of these trees have their roots still remaining, as well as the stumps of their branches. If there is any such thing in reality as fossile wood, it is generally allowed not to swim on the surface of the water; whereas all these before mentioned will: besides, they still retain the qualities of wood, and sometimes they are found swimming in pools, which the country people get out, cleave into splinters, and make use of them instead of candles. The chief difficulty lies in knowing whether firs ever grew in England or not; and some, to solve this, have pretended that they have been brought hither by some flood, particularly that of Noah, where they have lain ever since. It must be acknowledged, that there is no impossibility in this, or at least that they may have been brought hither by some such means; because they are full of a large quantity of bitumen, which no doubt would preserve them from corruption a vast number of years. However, this account is not very probable, because if they had been brought hither by a flood, they would have been found in all the low places alike, and in the south of England as well as in the north; for there are none in the vales of Evesham and Aylesbury, nor indeed in many others, which seem to be most likely. Some of these trees appear as if they were burnt, and others have the marks of the ax still remaining upon them; besides, the stumps, from which they were cut, are in some places also remaining, and appear in the same posture as when the tree was growing; particularly in Shebben Pool, when the summer is dry and the waters low. Others, with more probability, have thought that these trees were not fir, but birch or alder; because they delight to grow in moist places, and having been soaked many years in a bituminous stuff, have been so well impregnated with an oily matter as to imitate fir both in smell and burning: however, this can hardly be the case, because they

split exactly like fir, and because they have evidently a turpentine smell; and besides, at Axholm in Lincolnshire, there have been found trees thirty-six yards long, exclusive of the tops, which lay very near the roots to which they belonged. But it would detain the reader too long, and be foreign to our present purpose, to endeavour to account for the manner in which these trees have been brought into this island.

Other trees, besides firs, have been found to have been buried under ground; for Dr. Moreton takes notice of a small maple-tree that he met with in a stratum of clay at a considerable depth; and near Bath part of an elm-tree has been discovered of a considerable length: no doubt there have been many others, which have not been thought worth notice. But besides entire trees, or the principal parts, there have been commonly found in the fuel known in many parts of England by the name of Peat, and which is dug out of the earth, several fruits and catkins of other trees, that have been little altered in their texture. The most common of these are hazle-nuts; and near Whitlesea the twigs, as well as leaves, of white poplar have been seen, with the branches of hazle, and great numbers of the skeletons of leaves and catkins, besides the stones of plumbs or some such fruit. There have been some pretty large branches of trees found in the strata of stone, and commonly more or less changed into the nature of the strata in which they lay. A great variety of smaller branches have been found in the strata of blue clay, which serves to make tiles in the neighbourhood of London; but though they were in their original shape, yet their internal structure was much altered; for they seemed to be changed into the substance of the common vitriolic pyrites. These, and others of the like kind, are thought to have been branches of oak, and they are generally altered in some sense to the nature of the strata in which they lie, by the insinuation of crystal or stony particles; but in some the veins of the wood are still preserved, and appear very beautiful when polished.

Dr. Plott takes notice of stones which he calls STELECHITES, whereof one in his time was met with near Dudley, called by the country people the Pox Stone, that is, a stone which undergoes little alteration by fire. It was so much like petrified wood, that he took it for the stump of a tree at first sight. There are others of this name that are not so worthy of it, particularly the Stelechites of Aldrovandus, that has the appearance of antimony; whereof many are found in the rocks near Beresford and Stanop, and among the rubble stones that lie loose above ground in the fields near Heatly and Bagots-Bromley. They are a sort of annular stones, regularly jointed and regularly streaked at the top and bottom; and therefore as unlike the trunk of a tree, though some of them are branched, as any thing can well be; nor indeed do they resemble the trunk or stem of any plant whatever. Mr. Ray takes them to be the petrified back or tail bones of fish, because they generally consist of several plates or pieces sticking together, like the vertebræ of the back-bones of some sorts of fish; though he acknowledges, that they are shorter and thinner than the bones of any fish he had then seen.

Besides trees, and parts of trees, there have been different kinds of plants, which have undergone the same fate; and have either been wrapped in the black slaty stone found over the strata of coals; or in loose stones of a ferruginous substance. Some sorts of stones contain the perfect images of plants, which seem to be nothing more than a painting, because the fluid contained in the plant, has so intimately penetrated the substance of the stone, that it seems to be all of a piece with it, and has preserved no-  
thing



thing more than the figure. The plants that are thus found are of different sorts, but the most common are of the fern kind, yet not such as we have in England; for some pretend they are only to be met with in America. There are also a great number of sea mosses, with which many parts of the bottom of the sea are covered. An ear of barley has been found in one, or at least its image, very exactly painted. Some of the stones, when they have been split, have contained the figure only of the plant, while the other side has appeared more prominent; which seems to have been occasioned by the petrification of the plant itself. Some of the ferns thus found have been different from any species hitherto known; insomuch that it is hard to say, whether or not they were precedent to the formation of the present globe of the earth.

Though these impressions have been most commonly found in the slaty stones above mentioned, yet there have been other stones met with in which they have been seen, though perhaps not so commonly; particularly, there is a whitish stone in Germany, not much harder than chalk, in which they have been frequently seen; as also a grey slate stone of a very fine texture, where they have been often found, besides one of a blackish blue colour. Not only the entire branches of plants appear in these stones, but sometimes the leaves of trees; particularly those of the poplar, willow, white thorn, pear-trees, and many others.

Perhaps it will not be improper to take notice of others that are less singular, and which are common in Germany. These are the leaves of oak and other trees which hang over springs whose waters have a petrifying quality, by whose means they are often covered with a crust like the mosses in many parts of England. The stone that covers them seems chiefly to consist of a sort of spar. Many specimens of all these kinds are frequently to be met with in the cabinets of the curious.

Dr. Plott has met with some sorts of these petrifications in Oxfordshire, particularly at Somerton, where the grass is covered with a soft stone, yet in such a manner that when it is broken off the grass appears as fresh and green as before it was incrustated. Some of the blades of grass grow at least to a foot in length, and yet when pulled up with the root, and held up by that part, it might be pulled out as entire as a sword out of the scabbard. At North Aston, in a field north-west of the church, there is another petrifying water, where the roots of rushes, grass, and moss are in a short time eaten away, insomuch that nothing remains afterwards except the figures of those plants, with some augmentation. In the parish of St. Clement's in the suburbs of Oxford there is a ditch, the water whereof covers with a crust the sticks that fall out of a hedge. At Carfax, in the city itself, there is a pump, that not only covers the boards that fall into it with a crust, but also enters the very pores of the wood, which by degrees rotting away, there is nothing left at length but the linaments of the wood itself.

Petrifications of this kind are always very brittle; though they leave a faint representation of the grain of the wood, yet they never preserve its colour; and in the fire they are as incombustible as stone; for they change nothing but their colour, which becomes more whitish: however, they will entirely dissolve in aqua fortis. There are some indeed that are petrified in a different manner, and will preserve both the colour and texture of the wood: they are sometimes so hard that they will cut glass, and will always strike fire with steel.

The petrifications of marine substances are more common than those of any other sort; and among them are found fish of various kinds, more especially shell-fish, or rather the shell of those fish. However,

it is not very common to find any which represent the figures of river fish; though there is one called the Barbel Stone.

There are other fossils called OSTRACOMORPHOS, which consist of heaps of oyster-shells cemented together. There are many other petrified shells that are not found in clusters, but each of them lie single in a separate state. Of these some are curiously streaked or furrowed, and others plain, with few or no ornaments. Of these again some are of a turbinated form, and others bivalvular, joined together by a hinge, yet the shells of these are commonly found apart. Among these are those called the Stromboites, from their wreathing like a screw, and generally from the right hand to the left, and from the greater to the smaller end. The largest exceed nine inches in length; but those in England, at least that have been hitherto found, are not much above five, with a plain surface; and the least are not above half an inch long, but curiously streaked. They are of an ash colour, somewhat inclined to yellow, and of a harder consistence than the stone in which they lie.

There are some petrifications that resemble cockles, scollops, and oysters; and these are very numerous. The CONCHITES, or cockles, may be divided into the greater and the less; whereof some of the greater are streaked with broad streaks and pretty deep furrows, descending as it were from a centre at the top, and expanding themselves to the rim of the stone. They have also six or seven transverse simple lines, bent circularly to the hinge or joint; these appear to be a stone without, of a dark ash colour; but within they are found to be black flint. There are others again whose streaks descend from the hinge or joint, and yet not in straight lines, but undulated, and much broader than the former.

There are several kinds of the smaller Conchites, which differ in their colour, lines, and valves; for some are yellow, and are found in the fields near Burford in Oxfordshire; their valves rise high, and approach to a roundish shape. These made red hot, and put into beer, are accounted by the country people to be an immediate remedy for a stitch. In another part of this country, there are some of this sort that are flatter, and of an ash colour; but in both the lines run from the joint to the rim. These last are found only at the head of a spring, but never at any distance from it. Some of these have been found only streaked on one side, and rubble-stone on the other; and others have but just begun to be marked with lines.

There are others of this kind found in a bank of yellowish clay, and are of a different form from those just mentioned, for they are streaked transversely. Many of them appear to be hard stones, and yet several that have been met with were nothing but clay; which may justly raise a doubt, whether or not many of these, which have been generally supposed to be petrified shells, are properly so called.

There is another sort of Conchites found in Hornton quarry, nearly approaching to an oval, and scarcely streaked at all; which inclines Dr. Plott, as well as Dr. Lister, to think that these stones, which are so like cockles, never were in reality the shells of that fish.

There is still another sort of Conchites found in Hornton quarry, which is not stony on the inside like the former, but is hollow, and filled up with spar. It is sometimes in irregular figures, but generally forked. The base, or place where the branches of the fork are united, is at the joint or hinge of the valves; which seems somewhat hard to account for.

There are also petrifications or stones, which resemble scollop-shells, and are always found separate.



One of these is very curious, and resembles the Rough Scollop of Aldrovandus. It is of a yellowish colour, and has ears on both sides, with lines that run from the hinge or joint to the rim of the shell. These are very prominent; and there are others that run transversely, not bending towards, but from the hinge or joint; however, these do not pass through the deep furrows so as to join with each other, for they are only upon the ridges. There is another kind of scollop, where the direct and transverse lines are of an equal depth, but very shallow, very numerous and fine. In these the transverse lines bend towards the joint. It is of a light reddish colour, with ears on both sides, and is found in the quarries of Heddington in Oxfordshire.

There is another shell or stone like a small scollop, of a whitish yellow colour: the streaks are large and broad in proportion, but the transverse lines are small and narrow; however, it is eared, like the former, on both sides. These are called *Pectunculi* by Rondeletius, and he makes them a distinct species from the larger sort, which he names *Pectines*; but then those that he speaks of have never more than one ear, which is sometimes on the right, and sometimes on the left side; but this has ears on both sides. There is another of the small kind intirely without ears, nor is there any sign of the ears being broken off; however, there are real shells of this kind taken notice of by different authors. There is still another sort resembling a scollop, or, as some think, a sort of cockle, because it bears too much on one side for the former. It cannot be a *Tellenites*, because if it has any streaks at all, they never run that way. These are in great plenty in several parts of Oxfordshire; some of which are large, and as it were heaped one upon another; and others single, or found by themselves. The real shell-fish that answers to these are called *Streaked Cockles*; but they are always very smooth within, whereas some of these are evidently streaked on the inside; and the streaks not only run from the joint or hinge to the rim, but there are four or five broad transverse streaks, made up of several lines almost close to each other; for which reason some would have it to be a stone of a particular kind.

Besides the shells already mentioned, there are others that seem to be of the oyster kind, which are very common in the gravel-pits in some parts of Oxfordshire; among these, there is one of an oblong shape, which is very thick, and of a bluish colour, and seems to be the same as the thick oblong concha taken notice of by Dr. Merrett, which he found in Worcestershire, where they are called *Crow-stones*, *Crow-cups*, and *Egg-stones*.

There are other shells or stones that have some resemblance to muscles; but they are of an odd sort of a figure, and there are no real shells that we know of like them. They are not hollow, but are filled on the inside with a stony earth of a yellowish colour, and their covering is white and shining, with oblong lines. It is very long and narrow in proportion, and is marked, but very faintly, like the shell of a common muscle.

There are other petrifications resembling shell-fish, of the softer crustaceous kind, such as the Sea Urchin, which for substance and hardness are much like a pebble, and of a yellowish colour. They are divided at first by five pretty straight lines, adorned on each side by a double row of points, ascending from a protuberant centre in the basis of the stone to another shape at the top, but foliated round in the manner of a rose. It is likewise subdivided by five other indented lines, which terminate before they reach the centre; but they make the spaces between them appear like pentagons, or like the shells of some kinds of tortoises. Aldrovandus takes notice of a stone of this kind, which he ima-

gined resembled the Sea Hedge-hog deprived of its prickly coat. Dr. Plott calls it the *Porcupine Stone* without bristles. There is another that is curiously embroidered and resembles the Sea Hedge-hog of Imperatus. It is of a whitish ash colour without, but within is a hard black flint covered over with thin glittering plates placed edgeways on the ball of the flint, and which compose the uniform eminences and depressures with waved and transverse lines. Some Writers call these *Serpents Eggs*.

There is another sort of *Hedge-Hog Stone*, which resembles the shell of a kind of sea hedge-hog, and is said to be like the stellated eggs of that hedge-hog. Their outermost coat is full of sharp prickles, upon which account they are sometimes called *Sea Chest-nuts*, because of their likeness to the rough prickles that encompass chestnuts while they are on the tree. When they are dead, all the prickles will fall off, and then the shell is discovered, which is curiously wrought, and resembles the stone of which we are now speaking. They consist of many compartments and eminences, which are so regularly disposed, that the most ingenious embroiderer cannot easily imitate them. It may be doubted, whether there is any animal with a shell like this stone; for no account has been given of any such hitherto. There is also another kind of *Echinites* or *Hedge-hog Stone* found in the quarries near Shotover Hill. The inward shell of this fish is very small though the prickles are long and stiff; and it is always found in the deepest waters sticking to the rocks.

The *Cornu Ammonis*, or *Ammon's Horn*, is so called because it is like the horns of rams, which were consecrated in the temple of Jupiter Ammon, seated in the sandy deserts of Lybia. They were formerly taken to be petrified serpents, and several authors have compared them to the nautilus, or have confounded them with each other. The unpetrified *Ammon's Horns* are divided by several partitions; but they have fewer sinuosities than the nautilus, and they have no small pipes that run through them to preserve a communication one with another. There is also some difference in their covering; for the nautilus is very smooth, or at least the streaks of the surface only answer to the windings on the inside, and are very broad; whereas *Ammon's Horns* have several external turns, are covered often with tubercles, and almost always with streaks. There are plenty of the fossil kind in the county of Oxford, which are of different colours, shapes and sizes, but always so curled up, that the place of the head is in the circumference, and the tail is in the centre of the stone. Some are small, with protuberant parts swelling almost to a round; others are broader and more depressed; but the lines in both are undulated, and extended from near the centre to a single edged ridge on the back of the stone. In this respect they differ from a third sort that has broader lines, but not undulated, and they terminate at the large protuberances on each side the stone, between which and the broad back thereof there run other lines; the whole body of the stone being likewise divided into sutures not much unlike the leaves of an oak.

A sort of these stones have been found in the parish of Cleydon in Oxfordshire, which have many more turns than the former, though they are not much bigger; but they are without a covering, and are of a yellowish colour, with streaks that run from the innermost part of the stone, and are all single, except that some of them are divided into two parts before they reach the rim of the stone, where they terminate with a back much more protuberant than the rest of the stone, though streaked in the same manner. There are also others met with that are not stones like the former, but consist of a fine stony earth, or hardened yellow clay; contrary to



the opinion of some authors, who affirm that they are all of the same consistence.

The OPHIOMORPHITES nearly resemble the former, and are so called from their being like serpents rolled up. Some of these are also found so soft, that it is easy to break them with the fingers; but there are others that consist of a hard bluish stone. They differ from these in their lines or furrows; for in the former the streaks are wider, and more open near the rim; but in some of these they are closer, and also united into pretty large protuberant knobs on each side the back of the stone, which in these is broad and somewhat rising, and is crossed by other crooked or curve lines that run between the eminences. There are other stones of this kind, that have only straight single ribs, which likewise terminate in straight ridges, that run on each side the back of the stone; between which there is a third that is more prominent, and might be taken for the spine of the back; however, it is not wreathed, but plain like those on each side of it. The largest of this kind in Oxfordshire was found at Langford, near Oxford, and is eleven inches over, and weighs seventeen pounds. The ribs are single, and there are no knobs or ridges at the back, which is plain and even.

The BELEMNITES are so called from the Greek word *Belemnion*, which signifies a dart, because they are nearly of that shape. Authors are not agreed in what class to place this stone. The shape is, however, sometimes conical, sometimes cylindrical, and they most commonly consist of a substance that is black and horny; the length is from two inches to eight, and the diameter from the sixth part of an inch to three or four inches in circumference. The inward parts consist of rays, and there is generally a cell at the large end, and a furrow that runs from the top to the bottom.

There are other stones that represent herbs and plants, among which are FUNGITES, or TUBEROIDES, so called from their resemblance to mushrooms: these are of an ash colour without, but a black flint within. Others resemble only the parts of plants, one of which has been met with like a root of briony broken off transversely, which shewed the small fibres that run from the centre to the circumference; as well as the other streaks that run down the sides, and the annular divisions. The colour also is so like that of briony, that it can hardly be distinguished from it, except by the weight. It was found in quarries of rubble-stone near Shotover-Hill in Oxfordshire.

There are other stones like the fruit of trees, some of which are called PYRIFORMES, from their likeness to pears: one of these was found of eleven inches in circumference, and in size and form resembling a king-pear. This was a black flint; but there is another that is whitish without, and yellow within, in the shape of a warden pear. Other stones have been found in the shape of apricots, with the cleft or furrow from the stalk to the top, exactly representing a real apricot; likewise there have been spars found resembling mulberries, and white flints in the shape of Lucca olives.

There are also stones in the shape of those belonging to fruits. Most of these have a kind of pedicle or stalk, from which they seem to have had their growth, and are ridged and furrowed the whole length of the stone. Their texture is very curious, they being made up of little thin plates, not unlike the stone called the Selenite, only they are opaque, and the bulk of the stone much different. The plates seem to be made up of strings, some of which run two ways, and others three, and according to their directions the stone will readily cleave; yet they are all oblique to the axis of the stone.

There are other stones that resemble animals either entirely or in part, among which there are some that seem to have been petrified reptiles, and very likely have been really such, which may easily be accounted for without the help of a flood. There are others that represent the shells of garden snails, and are very numerous. There are others called Worm-stones, which are of two sorts, and one of them is of a whitish yellow colour, but not hollow within; for they seem to be of the same texture with the pebble-stones among which they are found.

There are some stones that represent the parts of four-footed beasts; particularly in the quarries at Heddington there are some that are like the head of a horse, having the ears and crest of the mane, with the places of the eyes, as prominent as in a real horse; and the rest of the face entire, only the mouth and nose are wanting in them all. These are not uncommon, and they are of several sizes; though they are not taken notice of by any ancient authors. There are other stones in the form of hearts, and on account of their size are by authors called Bucardites, or stones like bulls hearts. They are of a whitish yellow colour, with a smooth plain surface; though there are some that are ribbed on each side; these are ten inches in circumference, and weigh about two pounds; and there have been some found that have weighed twice as much.

Dr. Plott met with some sort of stones in the quarries of the rubble-stone near Shotover, which were composed of filaments like hair; and which could not be the Polythrix of Pliny, because they are not greenish, nor the Bestrychites of Zoroaster, nor the Corroides of Pliny, because they are neither grey nor long. However, it is a sort of Thrichites, because it is most like the short hair of beasts. The colour is yellowish, and each hair when viewed through a microscope appears to be streaked and furrowed throughout its whole length.

Some stones have been found accurately representing the combs of bees, with the cells of each cavity all hexangular, exactly like those of honeycombs. There was one stone found in a marl-pit that was very like a mole both in the head and tail, but more especially in the foot; it was so very exact that it was divided into claws, and represented the foot of that animal in all particulars. Some have been found so nearly resembling the head of an Owl, as almost to imitate life, having the eyes and beak of that animal very perfect. Another was of the shape and size of a partridge's skull, with the eyes and short beak, and was hollowed behind just as if the brains had been taken out: to these may be added still another, which was the accurate representation of a pullet's heart, with the fat near the basis thereof, and the coronary vessels descending from it most exactly delineated. All these are taken notice of by Dr. Plott.

There are some stones that seem to belong to the oviparous quadrupeds, among which is the Bufonites or Toad-stone. Authors acquaint us there are two kinds of these, the first of which are those that are called Brontiae and Ombria, which are sometimes of a dusky reddish, yellowish or greenish colour, of the size of a hen's egg. From the flat or the concave side there generally runs five lines to the centre of the convex side, at equal distances, and marked with exceeding small tubercles.

There has been another stone found in the rubble-quarry near Shotover Hill, that is a lively representation of olfactory nerves entire and whole: many of these are of a yellowish colour, smooth without, and hollow within. Dr. Plott found another of an oval shape, and chiefly of a reddish colour; but at one end it had a circle of white within, which is a zone of the colour of the stone, and then a round pupil of white, so that it looked like an eye darkened by a cataract.

There



There are other stones, which resemble the ears of a man, though much less, and Dr. Plott calls them *Otites* or *Auriculares*; they are common in the rubble-quarries near Shotover, but more so in a bank near a spring at Somerton town's-end, eastward from the church. There are other stones met with in the shape of human breasts, having not only the nipple, but the areola studded with small protuberances, and therefore may be properly called *Mammillares*.

There are other stones, which exactly resemble the heart of a man, with the trunk of the descending part of the vena cava, as also the ascending part of the vein of the same name. Likewise from the left ventricle there proceeded the trunk of the great artery, and a portion of the same artery tending downwards. Within it appeared to be a whitish sort of flint, and certainly deserves the name of *Anthropocardites*.

Other stones have been found exactly representing the private parts of a man; and others in the shape of kidneys, with the trunk of one of the ureters descending from the hollow part of it. When found it was the colour of a kidney, and was so soft that it might be readily cut with a knife, that is, the part of it resembling an ureter; but in less than an hour's time it grew as hard as the rest of the stone. To this class may be added the *Triorchites*, or *Diorchites*, which resemble the testicles of man or beast.

Some stones have been met with in the shape of human bones; particularly one exactly resembling the lowermost part of the thigh-bone of a man, with the lower head; between which are the anterior and the larger posterior sinus, which is the seat of the strong ligament that rises out of the thigh, and that allows a passage to the vessels descending into the leg. A little above the sinus, where the bone seems to have been broken off, there is a shining spar-like substance, resembling marrow in the hollow of the bone. Its circumference near the head is exactly two feet, and at the top above the sinus about fifteen inches, and the weight is near twenty pounds; which shews that the bulk is too monstrous to have belonged to a man, though it is precisely of the same shape. With this there was found a tooth that weighed two ounces and a quarter; but it was not at all petrified, which perhaps may be owing to the nature of teeth, whose hardness and want of large pores do not so readily subject them to putrefaction: for the same reason in graves they are often found sound and good, when all the other parts have been consumed. Not far from Bath in Somersetshire, there have been hatfuls of teeth picked up by those who followed the plough, though no other bones were met with to which they might have been supposed to belong. We are informed by Tazellus in his history of Sicily, that two large skeletons were found, which, when they came to be touched, all fell into dust, except the teeth called the grinders. What animal the thigh-bone above mentioned did belong to is hard to say, though some have taken it to be the bone of an elephant brought over by the Romans when they were masters of this kingdom. However, it does not appear from any authors, that those animals were ever brought over into Britain; and yet it cannot be denied that several have been brought over hither for public shews: but whether any died in Oxfordshire, and were there buried, must be left to the judgment of the reader.

There has been a great number of monstrous teeth found in different parts of England; and in Essex there were two met with in the reign of Richard I which were large enough to make two hundred each of the common size. One dug up near Maidstone in Kent was near seven inches in circumference, and weighed five ounces and one eighth. In the year

1666, after the fire of London, when St. Mary Woolchurch was pulled down, there was a thigh-bone found larger than the above-mentioned, which however was not turned to stone. There was also another found in London three feet and two inches long. After all, we may be certain that these bones did not belong to elephants, because they are of a quite different shape, which has been found by comparing them together; and therefore Dr. Plott was of opinion they belonged to men or women. To support his opinion, he takes notice of the sizes of the several giants that have been mentioned by authors; and he likewise mentions a giant in France, who lived there about two hundred years ago: this man was said to be so tall, that a man of a common stature might go upright between his legs.

Dr. Plott likewise takes notice of a stone found at the foot of Shotover Hill, which represents the leg and foot of a man cut off above the ankle, and which from the toe to the heel is about a yard long. However, he does not take this to be a petrification, but a stone formed in this shape by the plastic power of nature.

Besides these stones resembling the parts of animals, there are others not unlike things made by art. Among these are some of the shape of buttons, and others like the heel of an old shoe, with the lifts plainly distinguished from each other. One of the button stones was found at Teynton in Oxfordshire, pretty near resembling a hair button.

Other stones have been seen like the bags called the Sleeves of Hippocrates, made use of by the chemists; and there have been three one above another, as they usually place them. Others have been found in the shape of a whetstone; and some in that of a cap. There is another stone of an ash colour called *Trochites*, from its likeness to a wheel; for it has rays or spokes which proceed from the center, like those of a cart-wheel from its nave. Some of these are called *Entrochi*, or *Wheels within Wheels*; the rays of one of the *Trochites* being in relieve, and always lying in the furrows between the two protuberances of the other, as in the sutures of a skull. The round part is smooth, and the nave is flat; from which, as in common wheels, the prominent rays proceed to the outward circumference, so as to leave furrows between them. They are joined together so curiously, that they seem to be the effect of art; for the spokes of one are inserted in the furrows of the other, so as to represent the sutures of a human skull. Sometimes there are twenty united together in this manner. When the *Entrochos* is smooth in every part, the spokes are prominent. These stones differ in colour from each other; for some are white, others ash-coloured, and others again yellow: they differ also in size, for the largest are near an inch broad, and about a third as much thick. It is found in Saxony, in the clefts of marble, of a whitish ash-colour.

The *Entrochi* of Staffordshire are much larger, longer, and consequently compounded of more trochites, than those of Yorkshire or Somersetshire; for some are three inches and a half in circumference, whose center or nave is half an inch over. One found in a rock was near six inches long, but it was so fast inclosed that it could not be got out entire. Some of two inches and a half long consisted of thirty-five trochites.

At Beresford, and other places in Staffordshire, there are stones that seem to be made up of thick trochites, that have no bore at all, nor any rays at the top proceeding from a solid centre; which is no wonder, because when they are broken they do not seem to consist of plates like the rest. There is another sort that seem to be made up of joints like the *Entrochi*, in which the trochites neither appear round nor square on their outermost rims, but sharp like



like the edge of a screw, tapering from the place of their joining, and are streaked on their surfaces; so that the rays of one do not enter into the furrows of the other, nor yet do the rays join to the centre at right angles; and this in these is a large cylinder of black flint. Neither are all these cylindrical as the former; for some of them taper upwards from a broad basis, the lowermost rims being greatest, and decreasing gradually to the top. Some of these are so different from the former, that they have a thin streaked plate passing from each rim to the sides of the cylindrical concavity; so that there appears a distinct concavity between each ring. Some again have others included within them, and appear like rings parallel to each other, and not like a screw, nor do the protuberant edges of the one enter into the furrows of the other, like the male and female screws.

Some sorts of these stones, that have such cavities, are in the form of five columns joined together without any addition; and others are bound by thin rings that stand pretty thick and at equal distances, which are not streaked. Some again are knit together by the same sort of rings, that are only in pairs, there being some distance between each pair; and others have four placed in the same manner. There is still another sort fenced in the same way, some of which are of an equal bigness from the bottom to the top, and are curiously wrought in small rings, first with two at some distance, and then with four close together; and so on alternately the whole length of the stone: but others, though like the former in other respects, are bigger both at the top and at the bottom, and resemble a pillar with a pedestal and capital. Lastly, there are some very small ones, that stand in cavities like straight smooth pillars, only they are marked with a row of knobs on each side; and there are others that look like so many buttons piled upon each other.

ASTERIÆ, or STAR-STONES, are found in several parts of the kingdom, and particularly in the fields about Cleydon in Oxfordshire. They consist of thin plates lying obliquely to the horizontal position, much after the manner of the Jews Stone; and the colour is various, according to the different soils in which they are found: for this reason, in Gloucestershire and Yorkshire, where they are taken out of a blue clay, they are nearly of the same colour, and break like flints with a dark shining surface. In Warwickshire, as well as in some parts of Gloucestershire, they are of an ash colour; and at Cleydon they are yellowish, because they are found in a yellowish earth. They are here about an inch and a half in length, and seldom less than an inch in circumference: and whereas in other countries they are so hard, that it is difficult, if at all possible, to separate one from another without spoiling them; yet if these are steeped in vinegar for a night, they may be divided the next morning with safety and ease. They likewise differ from those of other places in shape; for, besides the sculpture that makes up the angles, there is the representation of a rose in the middle thereof, which is not commonly seen in those found elsewhere.

Many of the longest jointed Star-Stones have some of their joints a little broader and more prominent than others, dividing the whole body as it were into certain conjugations of two, three, or more joints, which, as Dr. Lister observes, are marked with sets of wires, as he calls them.

The Star-Stones found in Staffordshire are exactly of the same shape, in which stars are commonly painted; for they have all five principal rays of an equal length, shape, and make, and proceeding from the centre, which is either solid or hollow, and where they join in angles of seventy-two degrees. They differ somewhat from each other in the dif-

ferent places where they are found, as also from those in Oxfordshire, as well as from those taken notice of by Dr. Lister in the Philosophical Transactions; for though they are placed on each other in columns, and seem to be fragments, some having three, four, or more joints, yet none of them seem to be made up of plates lying obliquely to the horizontal position of the star; and some of them have their angles so very acute, and consequently their sides so deeply furrowed, that they seem to represent the rowel of a spur, without any sculpture or indented future; but when there is any such, they are of a quite different kind from those already mentioned.

The first sort are placed in a case of a flinty kind of stone, consisting of five angles; and the rays proceed from a solid centre, of a coal-black colour, not bigger than a common pin; yet they are evidently of a flat figure, consisting of five angles; though the angles of the inner one do not point against the sharp rays of the outer, but against the deep furrows between them; however, they are both smoothly jointed, without any hatching or engraving.

The second sort consists of a flat and not hollow-sided piece, such as Dr. Lister has described in the Philosophical Transactions; and the hatchings thereof are very different from all his. There is one principal ray which extends itself from the centre to the extremity of each angle, with oblique lines proceeding upwards therefrom, in such a manner that they in some sense represent so many boughs of a tree.

The third kind has also flat sides; but the joints are all unequal, one of them being always more protuberant than the next, and so alternately throughout the whole column. It consists of twelve joints, and the hollow of each angle is neither hatched on the top, nor is the column bent, or the least inclining, as those commonly are which are of a greater length. These have the property of moving in vinegar, like the former; and this property seems to have been known to Roger Bacon near five hundred years ago; for in one of his epistles he affirms they would run in vinegar.

The ASTROITES are a kin to the Asteriæ, and are of different sizes, but are adorned all over with many stars; and there are no less than four different kinds found in Oxfordshire, in two whereof the stars are in mezzo-relievo, they being prominent and standing outwards, with the streaks descending from the center at the top and all sides to the rock on which they grow. Some of these are of a larger and others of a smaller kind, which are both found in the quarries of rubble-stone. There is a third sort, which are more beautiful than the rest, and are deeply engraved like a seal, and streaked from the prominent edges above, to a centre in the bottom. These are generally hexagons, and sometimes pentagons; and yet they agree with the former in this, that the stars are only superficial, and not found in the body of the stone.

The fourth sort has been imperfectly described by Gesner, and after him by several others. The streaks of these are like the third sort, descending in a concave; but from the edges are generally round, or with five angles at the top, and tend to a center, but not of their own kind, for they are smooth and apparently prominent. They are found in quarries of rubble-stone, and are stellated, not only on the surface of the stone, but quite through the depth thereof; yet not so as to have one continued star reach through the whole, but many, according to the thickness of the stone; for about ten of them lie in the depth of an inch, much after the same manner as the star-stones; only they are not separate, but join together, and make as it were so many rows



of the stone. Some of these are so large in France, that they have been there used for the building of walls and houses; but with us they are generally employed in paving causeways, particularly in Oxfordshire.

The property of moving in vinegar is common both to the *Asteriæ* and the *Astroits*; though the *Asteriæ* will move not only in a whole joint, but two or three connected together; whereas the *Astroits* must be broken into very small pieces before they will move. The *Asteriæ* has not only a progressive motion, but will turn round in vinegar, and will stir more briskly and longer than any other stone that vinegar has the like effect upon; and though it has been steeped therein for three or four days, yet when fresh is poured upon it, it will still emit a great many little bubbles as at first from underneath it, and at the instant it begins to move.

Linnæus places the *LAPIS JUDÆICUS*, or *Jews Stone*, among petrifications; and Boet informs us that it is in the shape of an olive, and is roundish, tender, and brittle, with streaks that run according to the length, and placed at equal distances, as if they were done by art. The colour is whitish, or a faint ash colour, thinning within, and it may be obliquely cloven into foliaceous plates. It is called a *Jews Stone*, because it has been found in Judæa, and other parts of Syria; but some of these have been found in England, particularly in Oxfordshire, which are of a more slender and longer shape than any sort of olive. Some are about two inches in length, and an inch and a half in circumference; but others have been met with less than an inch long, and not much above half an inch round. Most of them have a kind of pedicle or stalk, from which they seem to have had their growth, and there are ridges or furrows through the whole length of the stone. The ridges are marked with small knots, in four points placed in a square, and a fifth in the middle. Their texture is very curious, for they consist of thin plates, as above, not unlike the *scalenites*, only they are opaque.

Linnæus likewise places *CORAL*, *Madrepore*, and the like, among petrifications: and he calls them *Lithophytes*, though they have been commonly placed among sea plants. Those of the Coral kind are a little flexible, like wood, when in the water, and to a small degree when out of it; but they may be reduced into powder like chalk. There are a great many of this kind, which resemble small trees without leaves: others are in the form of a net, sometimes with large meshes, and sometimes with small. The inside of the branches seem to be of the nature of horn; for it has the same smell when put into the fire: but the bark is of a stony nature, and contains a great deal of salt. Coral, properly so called, is of a stony nature, and is placed in the animal kingdom, because it produces sea insects. Some of these are red, and others white, and others of various colours. However, the red, of the colour of vermillion, is best, and is by some said to be of the male kind, and that which is palish of the female. The white Coral is the next in value, and then the black; but those of the other colours some will not allow to be Corals, though they are found in the same places. It is always covered with a bark, and is stony, solid, and very hard, even in the water; though the branches are a little flexible, but soon grow hard in the air. The bark of Coral is a mixture of tartar and a fluid of a gluey nature; and though it is a little rough, it takes a very fine polish. Some take the black Coral to be the sea plant of a different nature.

Red Coral is not so much esteemed in Europe as it is in Asia, and particularly in Arabia. It is used for making several sorts of toys, such as spoons, heads of canes, knife-handles, sword-hilts, and

beads; and, when set in silver, it serves as a plaything for children, and is designed to rub their gums therewith, that they may breed their teeth more easily.

On the young branches of Coral there are found small eminences, pierced in the form of stars, and full of a milky fluid when they are just taken out of the water. Many learning men have thought sea plants to be nothing but petrifications, consisting of plates of salt, and layers of tartar, placed one upon another; and as coral always grows with its head downwards, in caverns of rocks in the sea, the situation has caused them to suspect that they were nothing else but petrifications like those found on the roofs of certain caves in the rocks. But since the discovery of the flowers of coral, and some other marine productions, it is not at all doubted but they have a regular organization; and if their seeds have not yet been perceived, it is because their smallness renders them imperceptible.

But some have thought that the generation of these plants is not owing to these seeds; because, as they always hang with their heads downwards, they would fall off to the bottoms of the caverns, and not place themselves on the top; but this difficulty may be removed, by supposing they are lighter than the sea water, and that the milk which surrounds them is of so thick a nature, that it may help to assist them in swimming. Hence indeed it may happen, that many of them may rise to the top of the water, and there perish; but then likewise others may ascend to the top of the caverns, and there fix themselves, and then they will grow like the coral from which they proceed. Hence we may conclude, from the regularity of these productions, the organization of their parts, the great numbers of small pores in their bark to receive the bitumen and other sea juices, the eminences regularly hollowed in the form of stars, which serve for the cases of flowers in the same shape, the vessels full of a milky fluid which is found between the bark and the body of the plant, to make it grow thicker by little and little, and the perpetual uniformity of the same circumstances; we say, from all these particularities we have reason to believe, that the bottom of the sea is covered with plants, with characteristics different from ours. In Spain they have a particular sort of a machine for the getting of Coral, particular at a promontory in Catalonia. This is a wooden cross which is very large, and in the centre there is a wooden ball of a great weight, to which a very long and thick rope is fastened. At each end of the cross they hang a net in the form of a bag, which being let down into the sea, there are proper persons, who know where the Coral is to be found, and have the care of managing the rope. They guide one or more ends of the cross into the caverns, and then the nets lay hold of the Coral, break it off, and let it fall into the hollow part of the net; and when they have got as much as can well be contained in each of them, the machine is drawn up. The Red Coral is only chosen for medicinal uses, and many authors have ascribed great virtues thereto, which are in a great measure imaginary; however, it cannot be denied that it is a good absorbent, and therefore is proper to restrain the orgasm of the blood, and to blunt the acrimony of the bile and other humours in various sorts of fluxes, as well as for the gripes in children. Its dose is from a scruple to a drachm.

The *MADREPORE* has no bark like the former, but it is branched like it, though the branches are not so numerous. There are several sorts of them, and some are only a thick plate of a hardish stony matter, pierced with a great number of holes or pores, which are disposed in the form of small pipes, waves, stars, and other figures; but it is most commonly in the shape of a small tree, and the branches



are always full of holes or pores. It is found in various parts of the world, but no where in such great plenty as near the Caribbee islands.

There are several sorts of them, as the stellated Madreporé akin to Coral; the branched Madreporé akin to Coral; the Madreporé or Milleporé of Tournefort; the common Madreporé or fistulous white Coral; the Madreporé like southernwood; the warty-pointed Madreporé, by some called the water-pointed white Coral; and the white stellated Madreporé.

Though Madreporé is generally found growing in the sea, yet it is sometimes found on the tops of mountains: that met with by Jussieu on Mount Chaumont in Normandy was porous, light, white, and in all respects like the common Madreporé. It is, like most petrifications, alkaline and absorbent, and has much the same virtues as Coral. In fluxes of the belly, the dose is from half a scruple to two scruples.

We cannot conclude this History of Minerals, &c. without paying that just tribute, which is due to the wise Author of Nature, who has not only provided man with every thing that is necessary either for his

use or amusement, but has furnished him with reason to enquire into their various properties. The beasts of the field either assist him in the ease of this labour, or supply him with the most nourishing food; the inhabitants of the air above him, and those of the waters beneath, furnish his table with the most delicate repasts; the earth affords him the most wholesome vegetables, which preserve the temperature of his body, and relieve those disorders which arise from too free a use of grosser food; beneath his feet, and deep in the bowels of the earth, inexhaustible treasures lie hid, such as gold, silver, and the most precious jewels; iron, to secure him in his habitation from assassination and plunder; and to make him every kind of instrument indispensibly necessary in agriculture, navigation, and mechanical arts. Vain indeed is the attempt to enumerate, in a few lines, those wonders of the creation! Let us, however, from what we have read, draw this conclusion, that, in proportion as we increase our knowledge of natural causes, the more elevated idea shall we have of him, who is the author of them all.





# NEW, COMPLETE, and UNIVERSAL BODY, or SYSTEM of NATURAL HISTORY;

Being a Grand, Accurate and Extensive

## Display of Animated Nature.

### B O O K VI.

*Containing the THEORY of the EARTH in general.*

**T**HE general history of the Earth, is a necessary study for those who desire to make themselves acquainted with nature and her productions, and the detail of singular circumstances of the life and manners of animals, or of the culture and vegetation of plants, belong perhaps, less to natural history than to the general results of observations made on the different matters which compose the terrestrial globe; the eminences, depths, and inequalities of its form, the motion of the sea, the direction of mountains, the position of quarries, the rapidity and effects of currents, &c. This is nature in its ample extent, and these are her principal operations; they influence all the rest, and the theory of these effects is a first science of which the intelligence of particular phenomena, as well as the exact knowledge of terrestrial substances depends.

#### C H A P. I.

Containing a Sketch of the UNIVERSE.

**T**HE world may be considered as one vast mansion, where man has been admitted to enjoy, to admire, and to be grateful. The first desires of savage nature are merely to gratify the importunities of sensual appetite, and to neglect the contemplation of things, barely satisfied with their enjoyment: the beauties of nature, and all the wonders of creation, have but little charms for a being taken up in obviating the wants of the day, and anxious for precarious subsistence.

Philosophers, therefore, who have testified such surprize at the want of curiosity in the ignorant, seem not to consider that they are usually employed in making provisions of a more important nature; in providing rather for the necessities than the amusements of life. It is not till our more pressing wants are sufficiently supplied, that we can attend to the calls of curiosity; so that in every age scientific refinement has been the latest effort of human industry.

But human curiosity, though at first slowly excited, being at last possessed of leisure for indulging its propensity, becomes one of the greatest amusements of life, and gives higher satisfactions than what even the senses can afford. A man of this disposition turns all nature into a magnificent theatre, replete with objects of wonder and surprize, and fitted up chiefly for his happiness and entertainment: he industriously examines all things, from the minutest insect to the most finished animal; and, when his limited organs can no longer make the disquisition, he sends out his imagination upon new enquiries.

Nothing, therefore, can be more august and striking than the idea which his reason, aided by his imagination, furnishes of the universe around him. Astronomers tell us, that this earth which we inhabit forms but a very minute part in that great assemblage of bodies of which the world is composed. It is a million of times less than the sun, by which it is enlightened. The planets also, which like it, are subordinate to the sun's influence, exceed the earth a thousand times in magnitude. These, which were at first supposed to wander in the heavens without any fixed path, and took their name from their apparent deviations, have long been found to perform their circuits with great exactness and strict regularity. They have been discovered as forming with our earth a system of bodies circulating round the sun, all obedient to one law, and impelled by one common influence.

Modern philosophy has taught us to believe that, when the great Author of nature began the work of creation, he chose to operate by second causes; and, that, suspending the constant exertion of his power, he endued matter with a quality by which the universal œconomy of nature might be continued, without his immediate assistance. This quality is called attraction; a sort of approximating influence, which all bodies, whether terrestrial or celestial, are found to possess; and which in all increases as the quantity of matter in each increases. The sun, by far the greatest body in our system, is, of consequence, possessed of much the greatest share of



of this attracting power; and all the planets of which our earth is one, are of course, entirely subject to its superior influence. Were this power; therefore, left uncontrouled by any other, the sun must quickly have attracted all the bodies of our celestial system to itself; but it is equably counteracted by another power of equal efficacy; namely a progressive force which each planet received when it was impelled forward, by the divine architect, upon its first formation. The heavenly bodies of our system being thus acted upon by two opposing powers; namely, by that of attraction, which draws them towards the sun; and that of impulsion, which drives them strait forward into the great void of space; they pursue a track between these contrary directions; and each like a stone whirled about in a sling, obeying two opposite forces, circulates round its great centre of heat and motion.

In this manner, therefore, is the harmony of our planetary system preserved. The sun, in the midst, gives heat, and light, and circular motion to the planets which surround it: Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, perform their constant circuits at different distances, each taking up a time to complete its revolutions proportion to the greatness of the circle which it is to describe. The lesser planets also, which are attendants upon some of the greater, are subject to the same laws; they circulate with the same exactness; and are, in the same manner, influenced by their respective centres of motion.

Besides those bodies which make a part of our peculiar system, and which may be said to reside within its great circumference; there are others, that frequently come among us, from the most distant tracts of space, and that seem like dangerous intruders upon the beautiful simplicity of nature. These are comets, whose appearance was once so terrible to mankind, the theory of which is better understood at present: we know that their number is much greater than that of the planets; and that, like these, they roll in orbits, in some measure, obedient to solar influence. Astronomers have endeavoured to calculate the returning periods of many of them; but experience has not, as yet, confirmed the veracity of their investigations: indeed, who can tell when those wanderers have made their excursions into other worlds and distant systems, what obstacles may be found to oppose their progress, to accelerate their motions, or retard their return?

But what we have hitherto attempted to sketch, is but a small part of that great fabric in which the Deity has thought proper to manifest his wisdom and omnipotence. There are multitudes of other bodies dispersed over the face of the heavens, that lie too remote for examination: these have no motion, such as the planets are found to possess, and are therefore, called fixed stars; and from their extreme brilliancy and their immense distance, philosophers have been induced to suppose them to be suns resembling that which enlivens our system; as the imagination also, once excited, is seldom content to stop, it has furnished each with an attendant system of planets belonging to itself, and has even induced some to deplore the fate of those systems, whose imagined suns, which sometimes happens, have become no longer visible.

But conjectures of this kind, which no reasoning can ascertain, nor experiment reach, are rather amusing than useful. Though we see the greatness and wisdom of the Deity in all the seeming worlds that surround us, it is our chief concern to trace him in that which we inhabit. The examination of the earth, the wonders of its contrivance, the history of its advantages, or of the seeming defects in its formation, are the proper business of the natural historian. A description of this earth, its animals,

vegetables, and minerals, is the most delightful entertainment the mind can be furnished with, as it is the most interesting and useful. We would beg leave, therefore, to conclude these common-place speculations, with an observation, which is not entirely so.

An use, hitherto not much insisted upon, that may result from the contemplation of celestial magnificence, is, that it will teach us to make an allowance for the apparent irregularities we find below. Whenever we can examine the works of the Deity at a proper point of distance, so as to take in the whole of his design, we see nothing but uniformity, beauty, and precision. The heavens present us with a plan, which, though inexpressibly magnificent, is yet regular beyond the power of invention. Whenever, therefore, we find any apparent defects in the earth, which we are about to consider, instead of attempting to reason ourselves into an opinion that they are beautiful, it will be wise to say, that we do not behold them at the proper point of distance, and that our eye is laid too close to the objects to take in the regularity of their connexion. In short, we may conclude that God, who is regular in his great productions, acts with equal uniformity in the little.

## C H A P. II.

Containing a short Survey of the GLOBE, from the light of Astronomy and Geography.

ALL the sciences are in some measure linked with each other, and before the one is ended the other begins. In a natural history, therefore of the earth, we must begin with a short account of its situation and form, as given us by astronomers and geographers: it will be sufficient however, upon this occasion, just to hint to the imagination, what they, by the most abstract reasonings, have forced upon the understanding. The earth we inhabit is, as has been said before, one of those bodies which circulate in our solar system; it is placed at an happy middle distance from the centre; and even seems in this respect, privileged beyond all other planets that depend upon our great luminary for their support. Less distant from the sun than Saturn, Jupiter, and Mars, and yet less parched up than Venus and Mercury, that are situated too near the violence of its power, the earth seems in a peculiar manner to share the bounty of the Creator: it is not, therefore, without reason, that mankind consider themselves as the peculiar objects of his providence and regard.

Besides that motion which the earth has round the sun, the circuit of which is performed in a year, it has another upon its own axle, which it performs in twenty-four hours. Thus like a chariot-wheel, it has a compound motion; for while it goes forward on its journey, it is at the same time turning upon itself. From the first of these two arise the grateful vicissitude of the seasons; from the second, that of day and night.

It may be also readily conceived that a body thus wheeling in circles will most probably be itself a sphere. The earth, beyond all possibility of doubt, is found to be so. Whenever its shadow happens to fall upon the moon, in an eclipse, it appears to be always circular, in whatever position it is projected: and it is easy to prove, that a body which in every position makes a circular shadow, must itself be round. The rotundity of the earth may be also proved from the meeting of two ships at sea: the top-mast of each are the first parts that are discovered by both, the under parts being hidden by the convexity of the globe which rises between them. The ships in this instance may be resembled to two



men who approach each other on the opposite sides of an hill: their heads will first be seen, and gradually as they come nearer they will come intirely into view.

However, though the earth's figure is said to be spherical, we ought only to conceive it as being nearly so. It has been found in the last age to be rather flatted at both poles, so that its form is commonly resembled to that of a turnep. The cause of this swelling of the equator is ascribed to the greater rapidity of the motion with which the parts of the earth are there carried round; and which, consequently, endeavouring to fly off, act in opposition to central attraction. The twirling of a mop may serve as an homely illustration; which, as every one has seen, spreads and grows broader in the middle as it continues to be turned round.

As the earth receives light and motion from the sun, so it derives much of its warmth and power of vegetation from the same beneficent source. However, the different parts of the globe participate of these advantages in very different proportions, and accordingly put on very different appearances; a polar prospect, and a landscape at the equator, are as opposite in their appearances as in their situation.

The polar regions, that receive the solar beams in a very oblique direction, and continue for one half of the year in night, receive but few of the genial comforts which other parts of the world enjoy. Nothing can be more mournful or hideous than the picture which travellers present of those wretched regions. The ground, which is rocky and barren, rears itself in every place in lofty mountains and inaccessible cliffs, and meets the mariner's eye at forty leagues from shore. These precipices, frightful in themselves, receive an additional horror from being constantly covered with ice and snow, which daily seem to accumulate and to fill all the vallies with increasing desolation. The few rocks and cliffs, that are bare of snow, look at a distance of a dark brown colour, and quite naked. Upon a nearer approach, however, they are found replete with many different veins of coloured stone, here and there spread over with a little earth, and a scanty portion of grass and heath. The internal parts of the country are still more desolate and deterring. In wandering through these solitudes, some plains appear covered with ice, that, at first glance, seem to promise the traveller an easy journey. But these are even more formidable and more unpassable than the mountains themselves, being cleft with dreadful chasms, and every where abounding with pits that threaten certain destruction. The seas that surround these inhospitable coasts, are still more astonishing, being covered with flakes of floating ice, that spread like extensive fields, or that rise out of the water like enormous mountains. These, which are composed of materials as clear and transparent as glass, assume many strange and fantastic appearances. Some of them look like churches or castles, with pointed turrets; some like ships in full sail; and people have often given themselves the fruitless toil to attempt piloting the imaginary vessels into harbour. There are still others that appear like large islands, with plains, valleys, and hills, which often rear their heads two hundred yards above the level of the sea; and although the height of these be amazing, yet their depth beneath is still more so; some of them being found to sink three hundred fathom under water.

The earth presents a very different appearance at the equator, where the sun-beams, darting directly downwards, burn up the lighter soils into extensive sandy deserts, or quicken all the moister tracts with incredible vegetation. In these regions, almost all the same inconveniencies are felt from the proxi-

mity of the sun, that in the former were endured from its absence. The deserts are intirely barren, except where they are found to produce serpents, and in such quantities, that some extensive plains seem almost entirely covered with them.

It not unfrequently happens also that this dry soil, which is so parched and comminuted by the force of the sun, rises with the smallest breeze of wind; and the sands being composed of parts almost as small as those of water, they assume a similar appearance, rolling onward in waves like those of a troubled sea, and overwhelming all they meet with inevitable destruction. On the other hand, those tracts which are fertile, teem with vegetation even to a noxious degree. The grass rises to such an height as often to require burning; the forests are impassable from underwoods, and so matted above, that even the sun, fierce as it is, can seldom penetrate. These are so thick as scarce to be extirpated; for the tops being so bound together by the climbing plants that grow round them, though an hundred should be cut at the bottom, yet not one would fall, as they mutually support each other. In these dark and tangled forests, beasts of various kinds, insects in astonishing abundance, and serpents of surprising magnitude, find a quiet retreat from man, and are seldom disturbed except by each other.

In this manner the extremes of our globe seem equally unfitted for the comforts and conveniencies of life; and, although the imagination may find an awful pleasure in contemplating the frightful precipices of Greenland, or the luxurious verdure of Africa, yet true happiness can only be found in the more moderate climates, where the gifts of nature may be enjoyed without incurring danger in obtaining them.

It is in the temperate zone, therefore, that all the arts of improving nature, and refining upon happiness, have been invented: and this part of the earth is, more properly speaking, the theatre of natural history. Although there be millions of animals and vegetables in the unexplored forests under the line, yet most of these may for ever continue unknown, as curiosity is there repressed by surrounding danger. But it is otherwise in these delightful regions which we inhabit, and where this art has had its beginning. Among us there is scarce a shrub, a flower, or an insect, without its particular history; scarce a plant that could be useful which has not been propagated; nor a weed that could be noxious which has not been pointed out.

### C H A P. III.

Containing a View of the Surface of the EARTH.

**I**F we take a slight survey of the surface of our globe, a thousand objects offer themselves, which, though long known, yet still demand our curiosity. The most obvious beauty that every where strikes the eye is the verdant covering of the earth, which is formed by an happy mixture of herbs and trees of various magnitudes and uses. It has been often remarked that no colour refreshes the sight so much as green; and it may be added, as a further proof of the assertion, that the inhabitants of those places where the fields are continually white with snow, generally become blind long before the usual course of nature.

This advantage, which arises from the verdure of the fields, is not a little improved by their agreeable inequalities. There is scarce two natural landscapes that offer prospects entirely resembling each other; their risings and depressions, their hills and valleys, are never entirely the same, but always offer



fer something new to entertain and refresh the imagination.

But to increase the beauties of the face of nature, the landscape is enlivened by springs and lakes, and intersected by rivulets. These lend a brightness to the prospect; give motion and coolness to the air; and, what is much more important, furnish health and subsistence to animated nature.

Such are the most obvious and tranquil objects that every where offer: but there are objects of a more awful and magnificent kind; the Mountain rising above the clouds, and topt with snow; the River pouring down its sides, increasing as it runs, and losing itself, at last, in the ocean; the Ocean spreading its immense sheet of waters over one half of the globe, swelling and subsiding at well-known intervals, and forming a communication between the most distant parts of the earth.

If we leave those objects that seem to be natural to our earth, and keep the same constant tenor, we are presented with the great irregularities of nature. The burning mountain; the abrupt precipice; the unfathomable cavern; the headlong cataract; and the rapid whirlpool.

If we carry our curiosity a little further, and descend to the objects immediately below the surface of the globe, we shall there find wonders still as amazing. We first perceive the earth for the most part lying in regular beds or layers, every bed growing thicker in proportion as it lies deeper, and its contents more compact and heavy. We shall find, almost wherever we make our subterranean enquiry, an amazing number of shells that belonged to aquatic animals. Here and there, at a distance from the sea, beds of oyster-shells, several yards thick, and many miles over; sometimes testaceous substances of various kinds on the tops of mountains, and often in the heart of the hardest marble. These, which are dug up by the peasants, in every country, are regarded with little curiosity; for being so very common, they are considered as substances entirely terrene. But it is otherwise with the enquirer after nature, who finds them, not only in shape but in substance, every way resembling those that are found in the sea; and he, therefore, is at a loss to account for their removal.

Yet not one part of nature alone, but all her productions and varieties, become the object of the speculative man's enquiry: he takes different views of nature from the inattentive spectator; and scarce an appearance, how common soever, but affords matter for his contemplation: he enquires how and why the surface of the earth has those risings and depressions which most men call natural; he demands in what manner the mountains were formed, and in what consist their uses; he asks from whence springs arise, and how rivers flow round the convexity of the globe; he enters into an examination of the ebbings and flowings, and the other wonders of the deep; he acquaints himself with the irregularities of nature, and endeavours to investigate their causes; by which, at least, he will become better versed in their history. The internal structure of the globe becomes an object of his curiosity; and, although his enquiries can fathom but a very little way, yet, if possessed with a spirit of theory, his imagination will supply the rest. He will endeavour to account for the situation of the marine fossils that are found in the earth, and for the appearance of the different beds of which it is composed. These have been the enquiries that have splendidly employed many of the philosophers of the last and present age; and, to a certain degree, they must be serviceable. But the worst of it is, that, as speculations amuse the writers more than facts, they may be often carried to an extravagant length; and that time may be spent in reasoning

upon nature, which might be more usefully employed in writing her history.

Too much speculation in natural history is certainly wrong; but there is a defect of an opposite nature that does much more prejudice; namely, that of silencing all enquiry, by alledging the benefits we receive from a thing, instead of investigating the cause of its production. If we enquire how a mountain came to be formed, such a reasoner, enumerating its benefits, answers, because God knew it would be useful. If we demand the cause of an earthquake, he finds some good produced by it, and alledges that as the cause of its explosion. Thus such an enquirer has some ready reason for every appearance in nature, which serves to swell his periods, and give splendor to his declamation: every thing about him is, on some account or other, declared to be good; and he thinks it presumption to scrutinize its defects, or endeavour to imagine how it might be better. Such writers, and there are many such, add very little to the advancement of knowledge. It is finely remarked by Bacon, that the investigation of final causes is a barren study; and, like a virgin dedicated to the Deity, brings forth nothing. In fact, those men who want to compel every appearance and every irregularity in nature into our service, and expatiate on their benefits, combat that very morality which they would seem to promote. God has permitted thousands of natural evils to exist in the world, because it is by their intervention that man is capable of moral evil; and he has permitted that we should be subject to moral evil, that we might do something to deserve eternal happiness by shewing we had rectitude to avoid it.

#### CHAP. IV.

##### A Review of the different THEORIES of the EARTH.

HUMAN invention has been exercised for several ages to account for the various irregularities of the earth. While those philosophers mentioned in the last chapter see nothing but beauty, symmetry, and order; there are others, who look upon the gloomy side of nature, enlarge on its defects, and seem to consider the earth, on which they tread, as one scene of extensive desolation. Beneath its surface they observe minerals and waters confusedly jumbled together; its different beds of earth irregularly lying upon each other; mountains rising from places that once were level; and hills sinking into vallies; whole regions swallowed by the sea, and others again rising out of its bosom: all these they suppose to be but a few of the changes that have been wrought in our globe; and they send out the imagination to describe its primæval state of beauty.

Of those who have written theories describing the manner of their original formation of the earth, or accounting for its present appearances, the most celebrated are Burnet, Whiston, Woodward, and Buffon. As speculation is endless, so it is not to be wondered that all these differ from each other, and give opposite accounts of the several changes, which they suppose our earth to have undergone. As the systems of each have had their admirers, it is, in some measure, incumbent upon the natural historian to be acquainted, at least, with their outlines; and, indeed, to know what others have even dreamed, in matters of science, is very useful, as it may often prevent us from indulging similar delusions ourselves, which we should never have adopted, but because we take them to be wholly our own. However, as entering into a detail of these theories,



ries, is rather furnishing an history of opinions than things, we will endeavour to be as concise as possible.

The first who formed this amusement of earth-making into system, was the celebrated Thomas Burnet, a man of polite learning and rapid imagination. His Sacred Theory, as he calls it, describing the changes which the earth has undergone, or shall hereafter undergo, is well known for the warmth with which it is imagined, and the weakness with which it is reasoned, for the elegance of its style, and the meanness of its philosophy. "The earth," says he, "before the deluge, was very differently formed for what it is at present: it was at first a fluid mass; a chaos composed of various substances, differing both in density and figure: those which were most heavy sunk to the centre, and formed in the middle of our globe an hard solid body; those of a lighter nature remained next; and the waters, which were lighter still, swam upon its surface, and covered the earth on every side. The air, and all those fluids which were lighter than water, floated upon this also; and in the same manner encompassed the globe; so that between the surrounding body of waters, and the circumambient air, there was formed a coat of oil, and other unctuous substances, lighter than water. However, as the air was still extremely impure, and must have carried up with it many of those earthy particles with which it once was intimately blended, it soon began to defecate, and to depose these particles upon the oily surface already mentioned, which soon uniting, the earth and oil formed that crust, which soon became an habitable surface, giving life to vegetation, and dwelling to animals.

"This imaginary antideluvian abode was very different from what we see it at present. The earth was light and rich; and formed of a substance entirely adapted to the feeble state of incipient vegetation: it was an uniform plain, every where covered with verdure; without mountains, without seas, or the smallest inequalities. It had no difference of seasons, for its equator was in the plain of the ecliptic, or, in other words, it turned directly opposite to the sun, so that it enjoyed one perpetual and luxuriant spring. However, this delightful face of nature did not long continue in the same state; for, after a time, it began to crack and open in fissures: a circumstance which always succeeds when the sun exhales the moisture from rich or marshy situations. The crimes of mankind had been for some time preparing to draw down the wrath of Heaven; and they, at length, induced the Deity to defer repairing these breaches in nature. Thus the chasms of the earth every day became wider, and, at length, they penetrated to the great abyss of waters; and the whole earth, in a manner, fell in. Then ensued a total disorder in the uniform beauty of the first creation, the terrene surface of the globe being broken down: as it sunk the waters gushed out in its place; the deluge became universal; all mankind, except eight persons, were destroyed, and their posterity condemned to toil upon the ruins of desolated nature."

It only remains to mention the manner in which he relieves the earth from this universal wreck, which would seem to be as difficult as even its first formation. "These great masses of earth falling into the abyss, drew down with them vast quantities also of air; and by dashing against each other, and breaking into small parts by the repeated violence of the shock, they, at length, left between them large cavities filled with nothing but air. These cavities naturally offered a bed to receive the influent waters; and in proportion as they filled, the face of the earth became once more visible. The higher parts of its broken surface, now become the tops of mountains, were the first that appeared; the

plains soon after came forward, and, at length, the whole globe was delivered from the waters, except the places in the lowest situations; so that the ocean and the seas are still a part of the ancient abyss that have not had a place to return. Islands and rocks are fragments of the earth's former crust; kingdoms and continents are larger masses of its broken substance; and all the inequalities that are to be found on the surface of the present earth, are owing to the accidental confusion into which both earth and waters were then thrown."

The next theorist was Woodward, who, in his Essay towards a Natural History of the Earth, which was only designed to precede a greater work, has endeavoured to give a more rational account of its appearances; and was, in fact, much better furnished for such an undertaking than any of his predecessors, being one of the most assiduous naturalists of his time. His little book, therefore, contains many important facts, relative to natural history, although his system may be weak and groundless.

He begins by asserting that all terrene substances are disposed in beds of various natures, lying horizontally one over the other, somewhat like the coats of an onion; that they are replete with shells, and other productions of the sea: these shells being found in the deepest cavities, and on the tops of the highest mountains. From these observations, which are warranted by experience, he proceeds to observe, that these shells and extraneous fossils are not productions of the earth, but are all actual remains of those animals which they are known to resemble; that all the beds of the earth lie under each other, in the order of their specific gravity; and that they are disposed as if they had been left there by subsiding waters. All these assertions he affirms with much earnestness, although daily experience contradicts him in some of them; particularly we find layers of stone often over the lightest soils, and the softest earth under the hardest bodies. However, having taken it for granted, that all the layers of the earth are found in the order of their specific gravity, the lightest at the top, and the heaviest next the centre, he consequently asserts, and it will not improbably follow, that all the substances of which the earth is composed, were once in an actual state of dissolution. This universal dissolution he takes to have happened at the time of the flood. He supposes that at that time a body of water, which was then in the centre of the earth, uniting with that which was found on the surface, so far separated the terrene parts as to mix altogether in one fluid mass; the contents of which afterwards sinking according to their respective gravities, produced the present appearances of the earth. Being aware, however, of an objection that fossil substances are not found dissolved, he exempts them from this universal dissolution, and, for that purpose, endeavours to shew that the parts of animals have a stronger cohesion than those of minerals; and that, while even the hardest rocks may be dissolved, bones and shells may still continue entire.

So much for Woodward; but of all the systems which were published respecting the earth's formation, that of Whiston was most applauded, and most opposed. Nor need we wonder; for being supported with all the parade of deep calculation, it awed the ignorant, and produced the approbation of such as would be thought otherwise, as it implied a knowledge of abstruse learning, to be even thought capable of comprehending what the writer aimed at. In fact, it is not easy to divest this theory of its mathematical garb; but those who have had leisure, have found the result of our philosopher's reasoning to be thus. He supposes the earth to have been originally a comet; and he considers the history



tory of the creation, as given us in scripture, to have its commencement just when it was, by the hand of the Creator, more regularly placed as a planet in our solar system. Before that time, he supposes it to have been a globe without beauty or proportion; a world in disorder; subject to all the vicissitudes which comets endure; some of which have been found, at different times, a thousand times hotter than melted iron; at others, a thousand times colder than ice. These alternations of heat and cold, continually melting and freezing the surface of the earth, he supposes to have produced, to a certain depth, a chaos entirely resembling that described by the poets, surrounding the solid contents of the earth, which still continued unchanged in the midst, making a great burning globe of more than two thousand leagues in diameter. This surrounding chaos, however, was far from being solid: he resembles it to a dense though fluid atmosphere, composed of substances mingled, agitated, and shocked against each other; and in this disorder he describes the earth to have been just at the eve of creation.

But upon its orbit's being then changed, when it was more regularly wheeled round the sun, every thing took its proper place; every part of the surrounding fluid then fell into a situation, in proportion as it was light or heavy. The middle, or central part, which always remained unchanged, still continued so, retaining a part of that heat which it received in its primæval approaches towards the sun; which he calculates, may continue for about six thousand years. Next to this fell the heavier parts of the chaotic atmosphere, which serve to sustain the lighter: but as in descending they could not entirely be separated from many watery parts, with which they were intimately mixed, they drew down a part of these also with them; and these could not mount again after the surface of the earth was consolidated: they, therefore, surrounded the heavy first descending parts, in the same manner as these surround the central globe. Thus the entire body of the earth is composed internally of a great burning globe: next which, is placed an heavy terrene substance, that encompasses it; round which also is circumsufed a body of water. Upon this body of water, the crust of earth on which we inhabit is placed: so that, according to him, the globe is composed of a number of coats, or shells, one within the other, all of different densities. The body of the earth being thus formed, the air, which is the lightest substance of all, surrounded its surface; and the beams of the sun darting through, produced that light which, we are told, first obeyed the Creator's command.

The whole œconomy of the creation being thus adjusted, it only remained to account for the risings and depressions on the surface of the earth, with the other seeming irregularities of its present appearance. The hills and vallies are considered by him as formed by their pressing upon the internal fluid, which sustains the outward shell of earth, with greater or less weight: those parts of the earth which are heaviest, sink into the subjacent fluid more deeply, and become vallies: those that are lightest rise higher upon the earth's surface, and are called mountains.

Such was the face of nature before the deluge; the earth was then more fertile and populous than it is at present; the life of man and animals was extended to ten times its present duration; and all these advantages arose from the superior heat of the central globe, which ever since has been cooling. As its heat was then in full power, the genial principle was also much greater than at present; vegetation and animal increase were carried on with more vigour; and all nature seemed teeming with the seeds of life. But these physical advantages

were only productive of moral evil; the warmth which invigorated the body encreased the passions and appetites of the mind; and, as man became more powerful, he grew less innocent. It was found necessary to punish this depravity; and all living creatures were overwhelmed by the deluge in universal destruction.

This deluge, which simple believers are willing to ascribe to a miracle, philosophers have long been desirous to account for by natural causes: they have proved that the earth could never supply from any reservoir towards its centre, nor the atmosphere by any discharge from above, such a quantity of water as would cover the surface of the globe to a certain depth over the tops of our highest mountains. Where, therefore, was all this water to be found? Whiston has found enough, and more than a sufficiency, in the tail of a comet; for he seems to allot comets a very active part in the great operations of nature.

He calculates, with great seeming precision, the year, the month, and the day of the week on which this comet (which has paid the earth some visits since, though at a kinder distance) involved our globe in its tail. The tail may be supposed to be a vaporous fluid substance, exhaled from the body of the comet, by the extreme heat of the sun, and increasing in proportion as it approached that great luminary. It was in this that our globe was involved at the time of the deluge; and as the earth still acted by its natural attraction, it drew to itself all the watery vapours which were in the comet's tail; and the internal waters being also at the same time let loose, in a very short space the tops of the highest mountains were laid under the deep.

The punishment of the deluge being thus completed, and all the guilty destroyed, the earth, which had been broken by the eruption of the internal waters, was also enlarged by it; so that upon the comet's recess, there was found room sufficient in the internal abyfs for the recess of the superfluous waters; whither they all retired, and left the earth uncovered, but in some respects changed, particularly in its figure, which, from being round, was now become oblate. In this universal wreck of nature Noah survived, by a variety of happy causes, to re-people the earth, and to give birth to a race of men slow in believing ill-imagined theories of the earth.

After so many theories of the earth, which had been published, applauded, answered, and forgotten, Mr. Buffon ventured to add one more to the number. This philosopher was, in every respect, better qualified than any of his predecessors for such an attempt, being furnished with more materials, having a brighter imagination to find new proofs, and a better style to cloath them in. However, in our opinion, this seems the weakest part of his admirable work; and we could wish, that he had been content with giving us facts instead of systems; that, instead of being a reasoner, he had contented himself with being merely an historian.

He begins his system by making a distinction between the first part of it and the last; the one being found only on conjecture, the other depending entirely upon actual observation. The latter part of his theory may, therefore, be true, though the former should be found erroneous.

The planets, says he, and the earth, among the number, might have been formerly (he only offers this as conjecture) a part of the body of the sun, and adherent to its substance. In this situation, a comet falling in upon that great body might have given it such a shock, and so shaken its whole frame, that some of its particles might have been driven off like streaming sparks from red hot iron; and each



of these streams of fire, small as they were in comparison of the sun, might have been large enough to have made an earth as great, nay many times greater than ours. So that in this manner the planets, together with the globe which we inhabit, might have been driven off from the body of the sun by an impulsive force: in this manner also they would continue to recede from it for ever, were they not drawn back by its superior power of attraction; and thus, by the combination of the two motions, they are wheeled round in circles.

Being in this manner detached at a distance from the body of the sun, the planets, from having been at first globes of liquid fire, gradually became cool. The earth also having been impelled obliquely forward, received a rotatory motion upon its axis at the very instant of its formation; and this motion being greatest at the equator, the parts there acting against the force of gravity, they must have swollen out, and given the earth an oblate or flatted figure.

As to its internal substance, our globe having once belonged to the sun, it continues to be an uniform mass of melted matter, very probably vitrified in its primæval fusion. But its surface is very differently composed. Having been in the beginning heated to a degree equal to, if not greater, than what comets are found to sustain, like them it had an atmosphere of vapours floating round it, and which cooling by degrees, condensed and subsided upon its surface. These vapours formed, according to their different densities, the earth, the water, and the air; the heavier parts falling first, and the lighter remaining still suspended.

Thus far our philosopher is, at least, as much a system-maker as Whiston or Burnet; and, indeed, he fights his way with great perseverance and ingenuity through a thousand objections that naturally arise. Having, at last, got upon the earth, he supposes himself on firmer ground, and goes forward with greater security. Turning his attention to the present appearance of things upon this globe, he pronounces from the view that the whole earth was at first under water. This water he supposes to have been the lighter parts of its former evaporation, which, while the earthy particles sunk downwards by their natural gravity, floated on the surface, and covered it for a considerable space of time.

"The surface of the earth," says he, "must have been in the beginning much less solid than it is at present; and, consequently, the same causes, which at this day produce but very slight changes, must then, upon so complying a substance, have had very considerable effects. We have no reason to doubt but that it was then covered with the waters of the sea; and that those waters were above the tops of our highest mountains, since, even in such elevated situations, we find shells and other marine productions in very great abundance. It appears also that the sea continued for a considerable time upon the face of the earth: for as these layers of shells are found so very frequent at such great depths, and in such prodigious quantities, it seems impossible for such numbers to have been supported all alive at one time; so that they must have been brought there by successive depositions. These shells also are found in the bodies of the hardest rocks, where they could not have been deposited, all at once, at the time of the deluge, or at any such instant revolution; since that would be to suppose, that all the rocks in which they are found, were, at that instant, in a state of dissolution, which would be absurd to assert. The sea, therefore, deposited them where-soever they are now to be found, and that by slow and successive degrees.

"It will appear, also, that the sea covered the whole

earth, from the appearance of its layers, which lying regularly one above the other, seem all to resemble the sediment formed at different times by the ocean. Hence, by the irregular force of its waves, and its currents driving the bottom into sand-banks, mountains must have been gradually formed within this universal covering of waters; and these successively raising their heads above its surface, must, in time, have formed the highest ridges of mountains upon land, together with continents, islands and low grounds, all in their turns. This opinion will receive additional weight by considering, that in those parts of the earth where the power of the ocean is greatest, the inequalities on the surface of the earth are highest: the ocean's power is greatest at the equator, where its winds and tides are most constant; and, in fact, the mountains at the equator are found to be higher than in any other part of the world. The sea, therefore, has produced the principal changes in our earth: rivers, volcanoes, earthquakes, storms, and rain, having made but slight alterations, and only such as have affected the globe to very inconsiderable depths."

This is but a very slight sketch of Mr. Buffon's Theory of the Earth; a theory which he has much more powerfully supported, than happily invented; and it would be needless to take up the reader's time from the pursuit of truth in the discussion of plausibilities. In fact, a thousand questions might be asked this most ingenious philosopher, which he would not find it easy to answer; but such is the lot of humanity, that a single Goth can in one day destroy the fabric which Cæsars were employed an age in erecting. We might ask, how mountains, which are composed of the most compact and ponderous substances, should be the first whose parts the sea began to remove? We might ask, how fossil-wood is found deeper even than shells? which argues, that trees grew upon the places he supposes once to have been covered with the ocean. But we hope this excellent man is better employed than to think of gratifying the petulance of incredulity, by answering endless objections.

## CHAP. V.

Containing the NATURAL HISTORY of FOSSIL-SHELLS, and other extraneous FOSSILS.

WE may affirm of Mr. Buffon, that which has been said of the chymists of old: though he may have failed in attaining his principal aim, of establishing a theory, yet he has brought together such a multitude of facts relative to the history of the earth, and the nature of its fossil productions, that curiosity finds ample compensation even while it feels the want of conviction.

Before, therefore, we enter upon the description of those parts of the earth, which seem more naturally to fall within the subject, it will not be improper to give a short history of those animal productions that are found in such quantities, either upon its surface, or at different depths below it. They demand our curiosity, and, indeed, there is nothing in natural history that has afforded more scope for doubt, conjecture, and speculation. Whatever depths of the earth we examine, or at whatever distance within land we seek, we most commonly find a number of fossil-shells, which being compared with others from the sea, of known kinds, are found to be exactly of a similar shape and nature. They are found at the very bottom of quarries and mines, in the retired and inward parts of the most firm and solid rocks, upon the tops of even the highest hills and mountains, as well as in the valleys and plains: and this



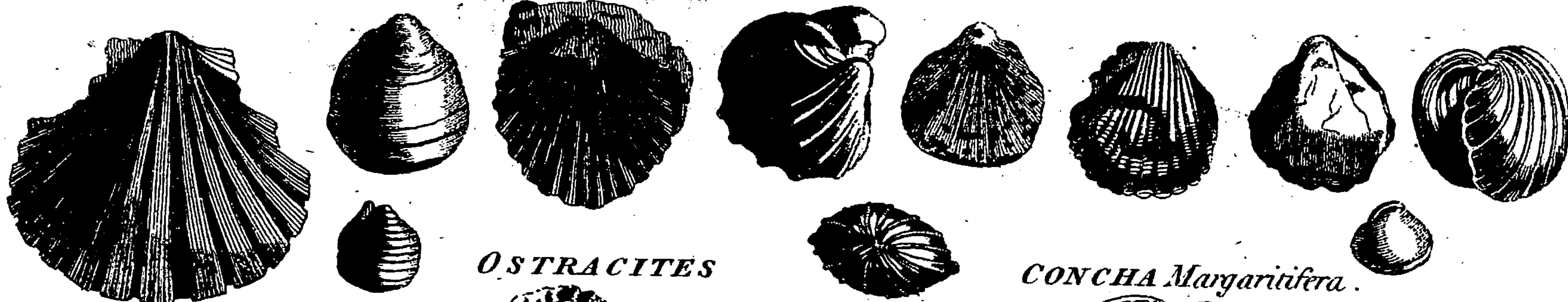




# FOSSILS.

## Class IX. Fossil Shells.

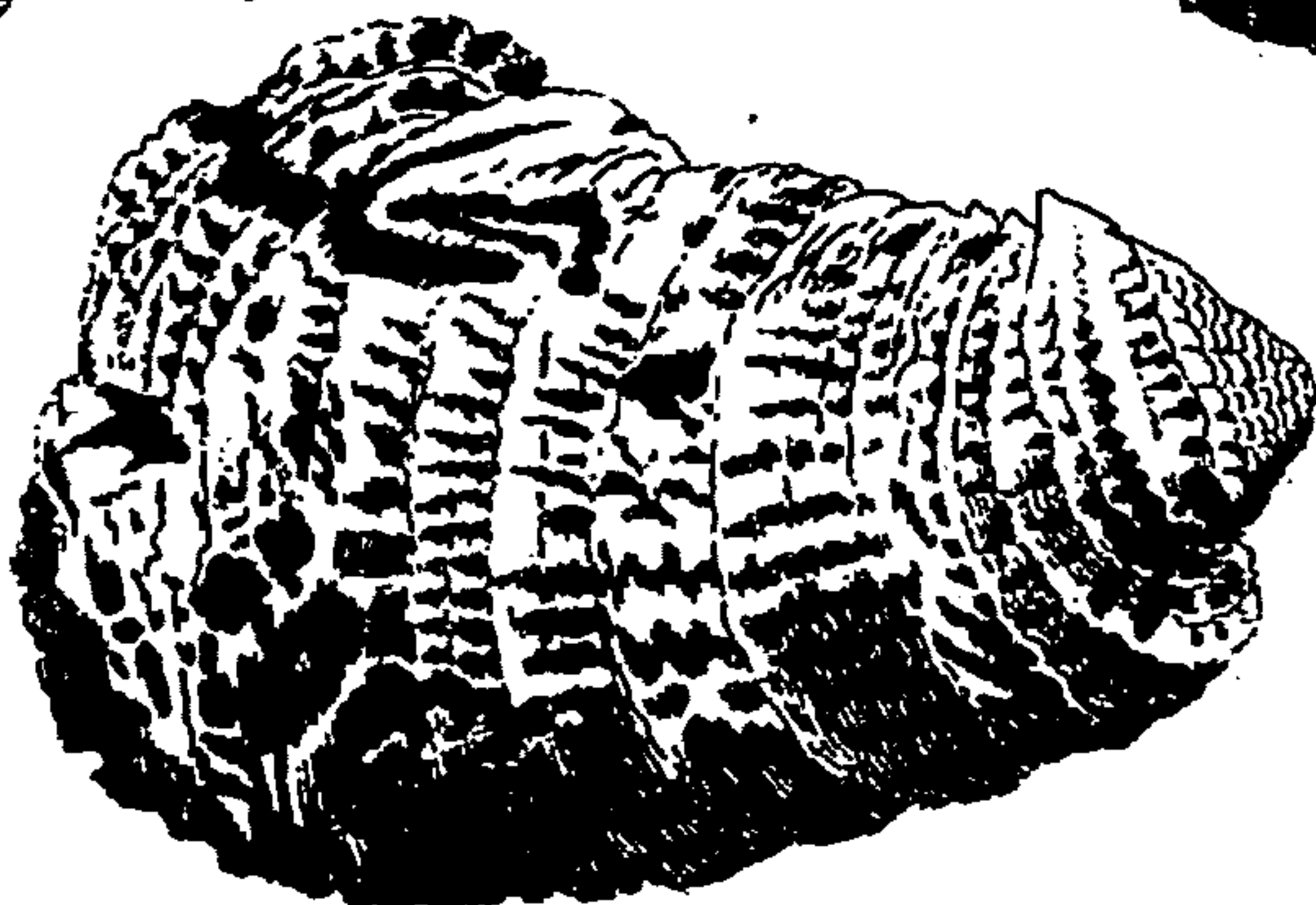
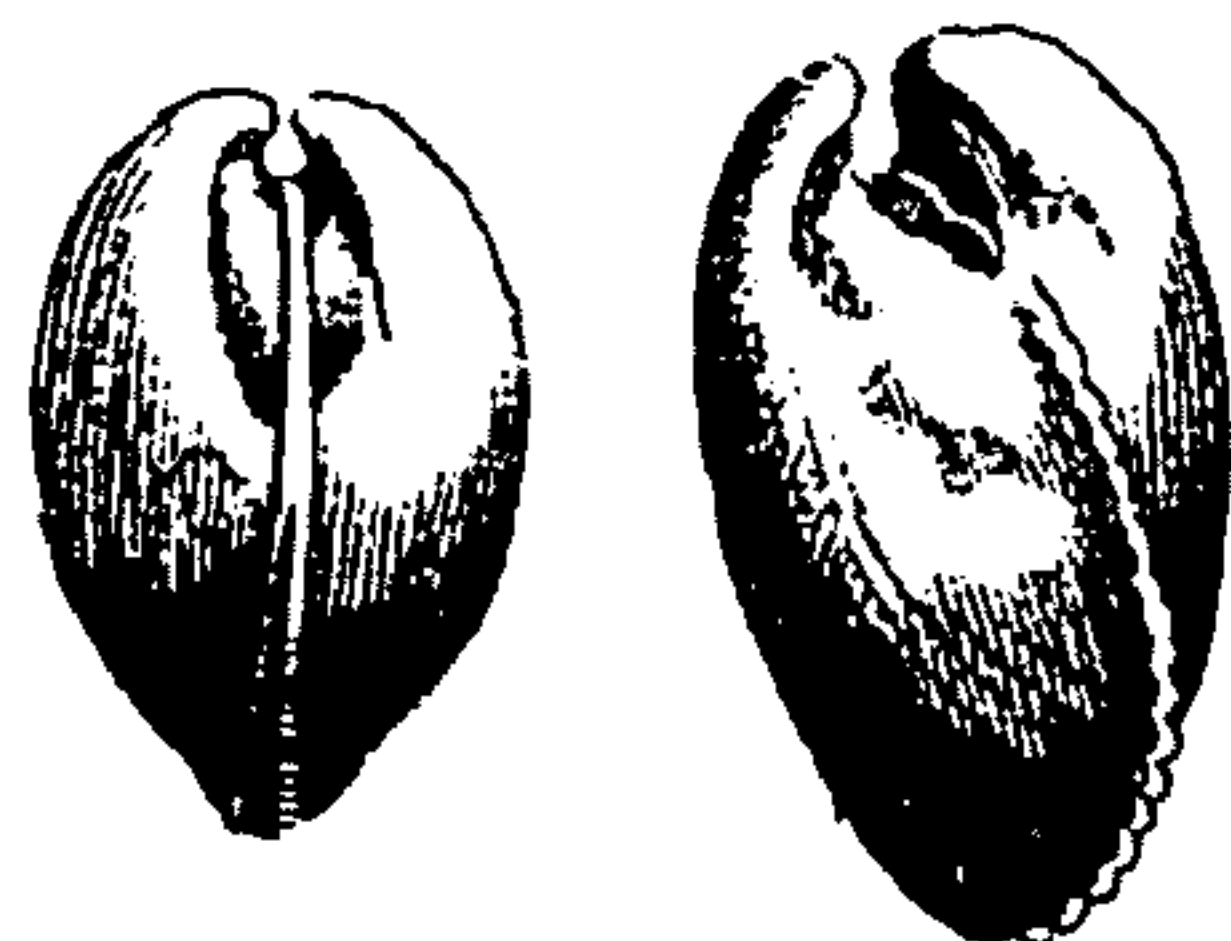
P E C T E N



OSTRACITES

CONCHA Margaritifera.

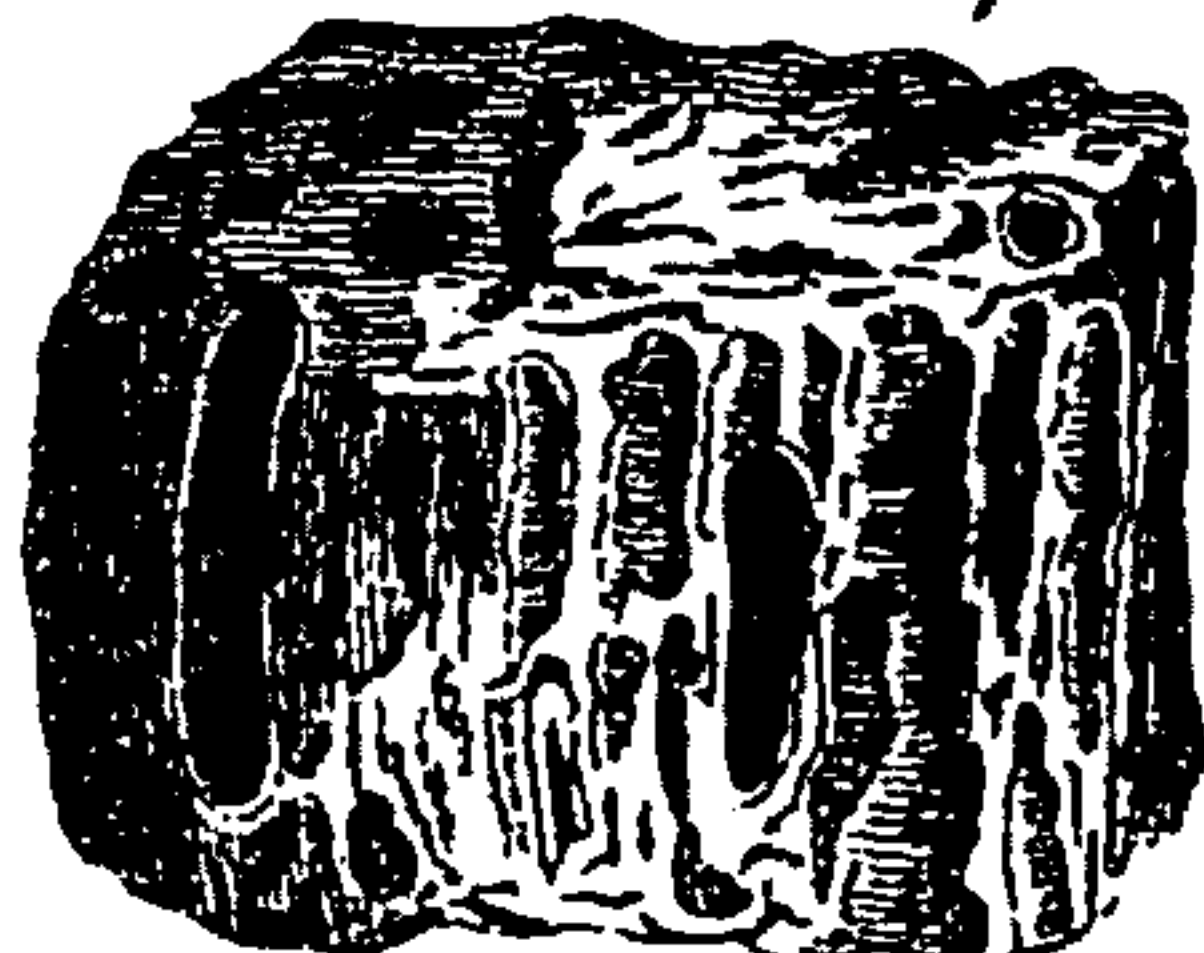
BUCARDITÆ



TIBULLUS Marinus.



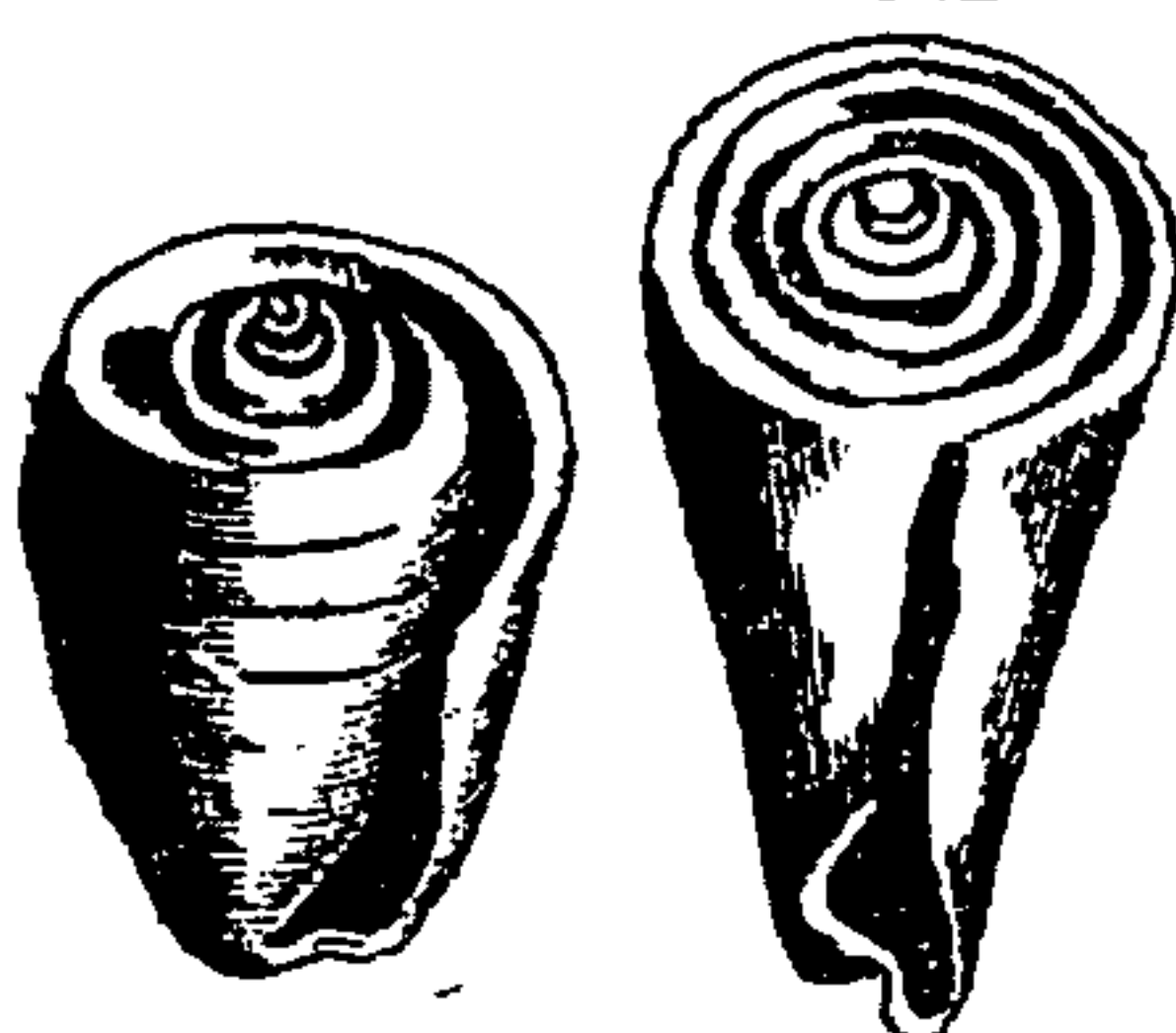
SYRINGOIDES Lapis.



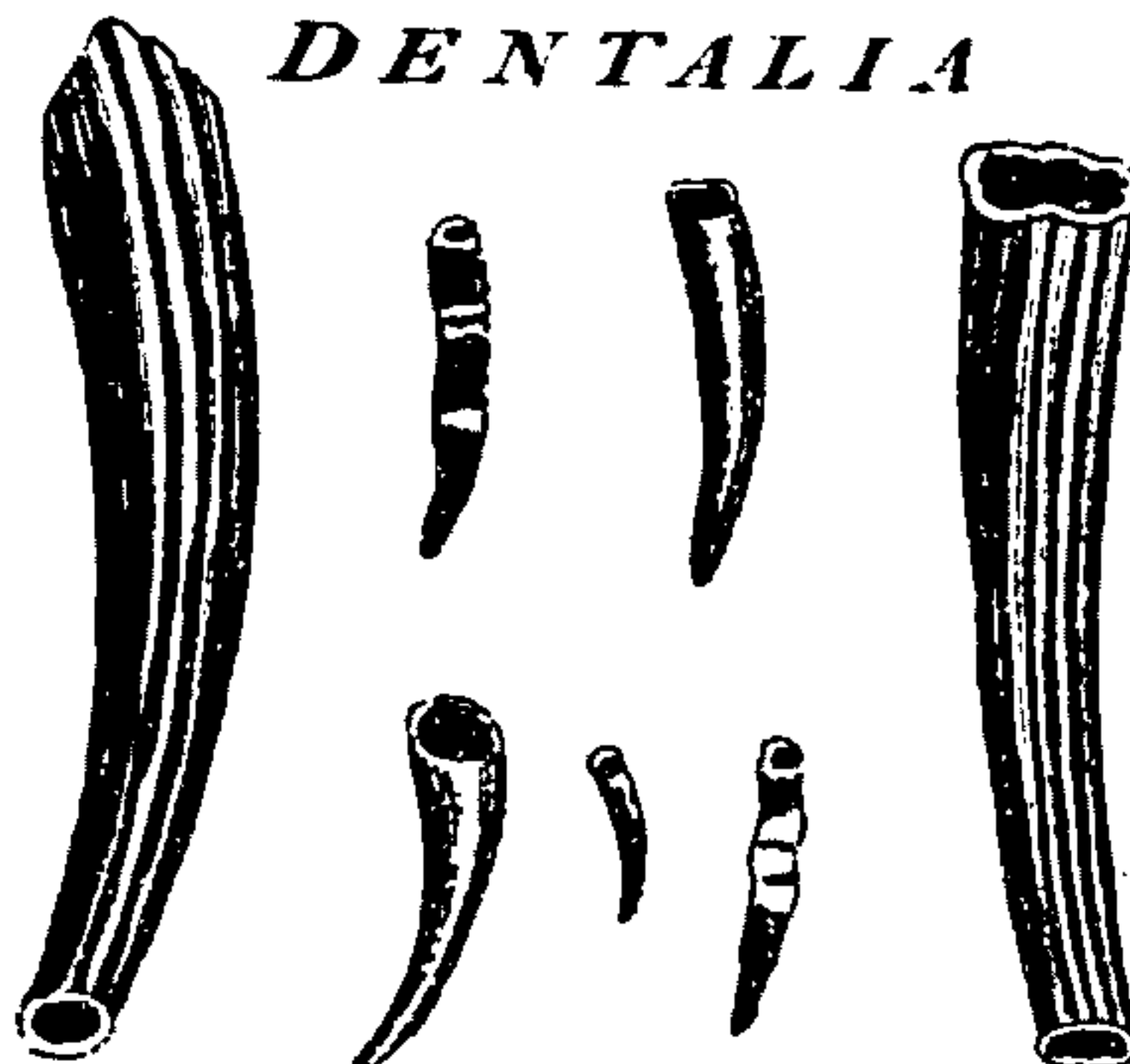
TROCHI



CYLINDRI



DENTALIA



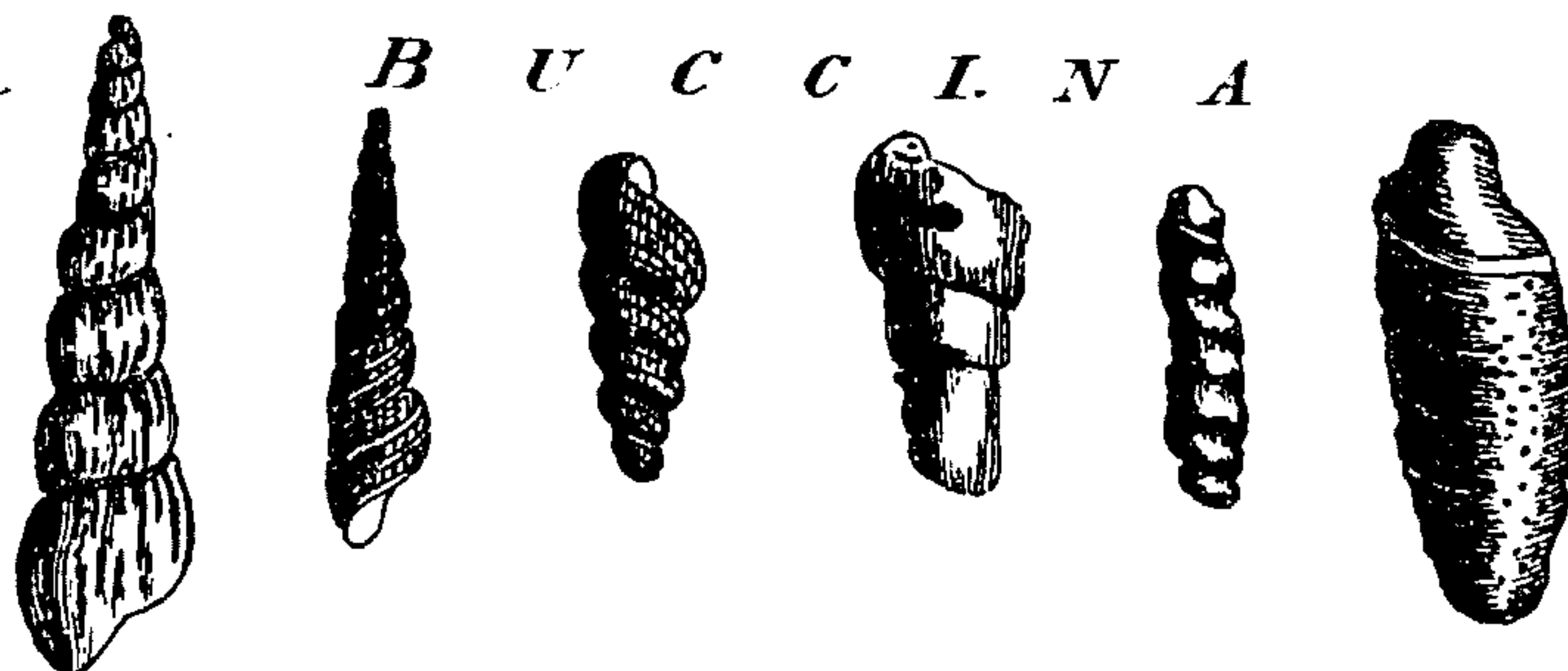
COCHLEÆ



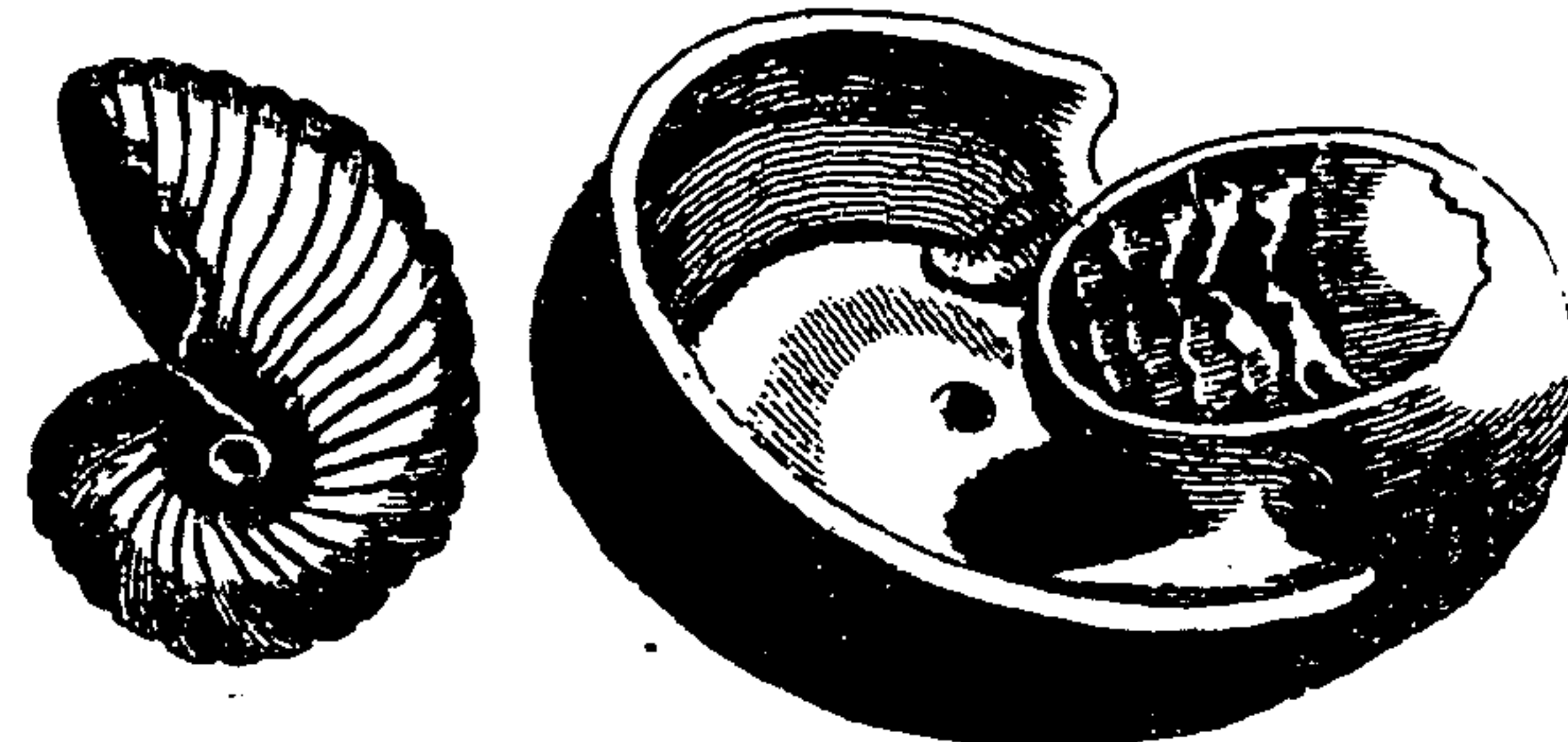
NERITÆ



B U C C I N A



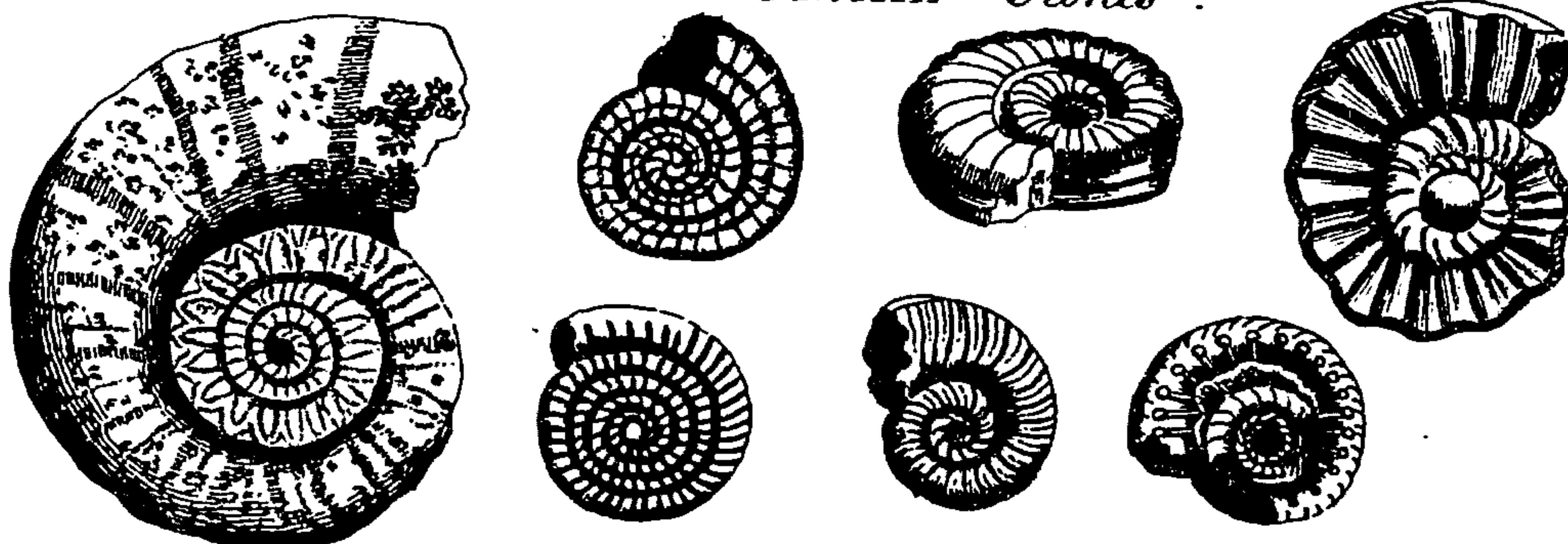
A U T I L I



CONCHÆ Anomia.

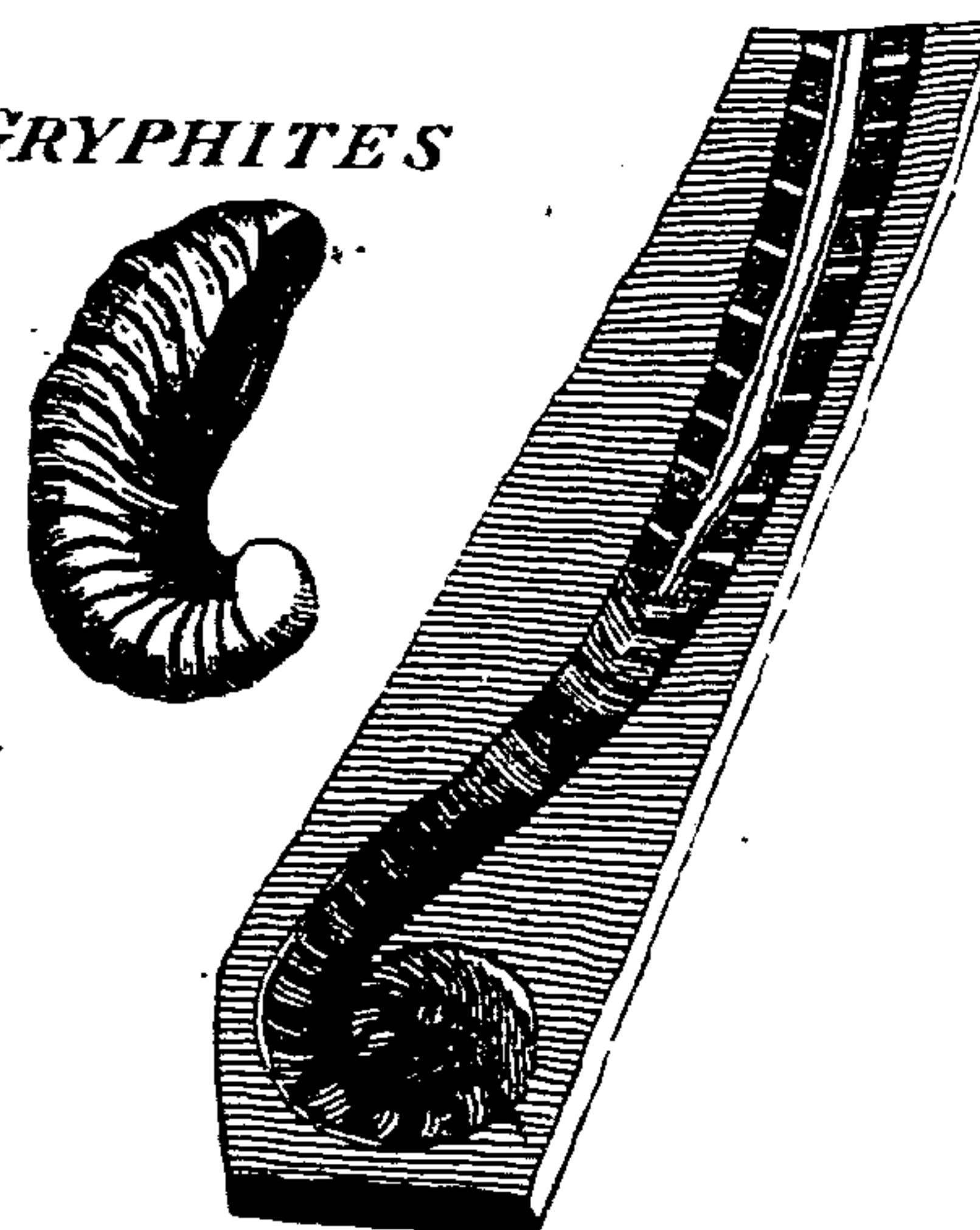


Ammonitæ or SNAKE Stones.



ORTHO CERATITES

GRYPHITES

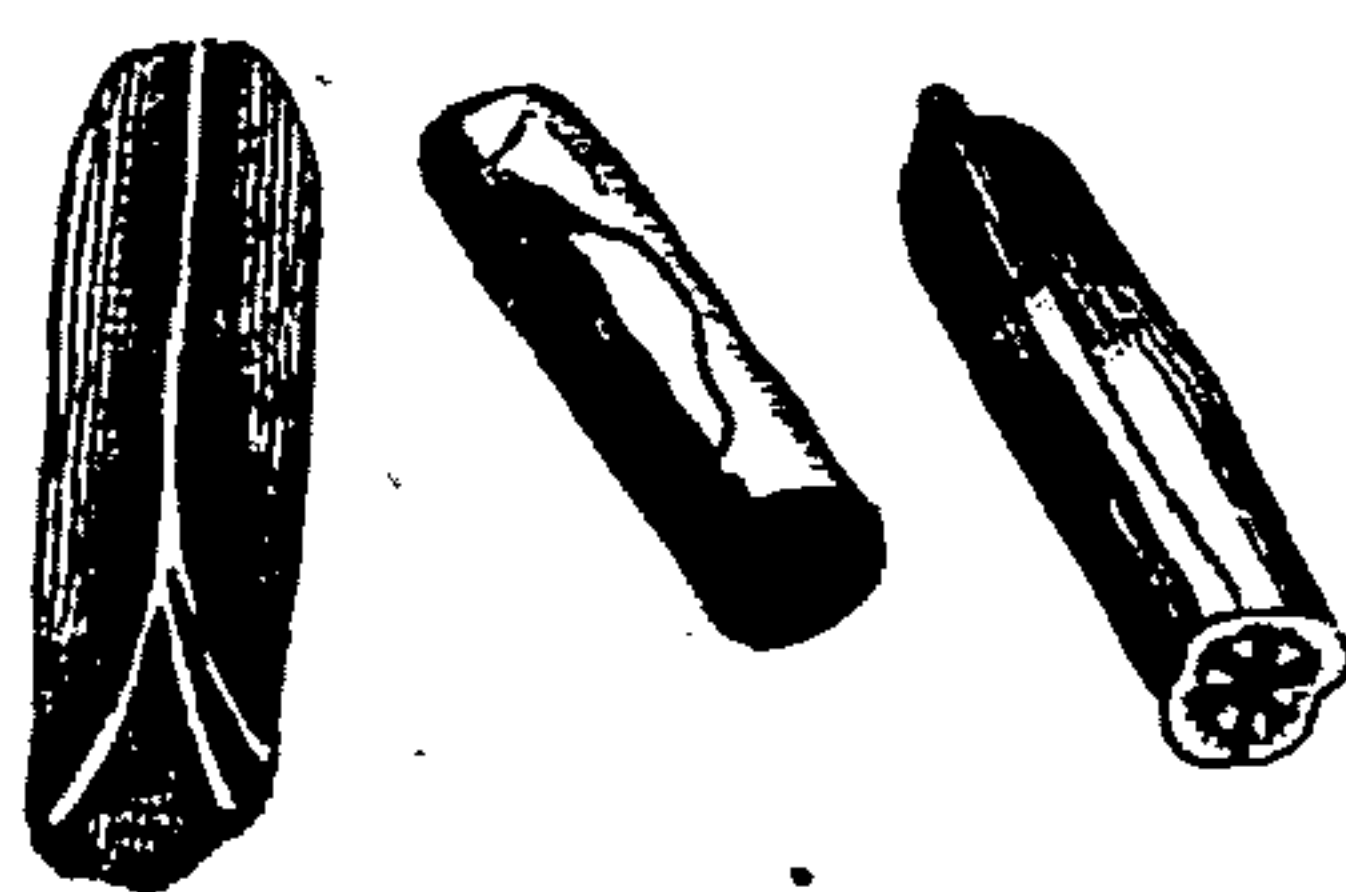


E C H I N I T Æ

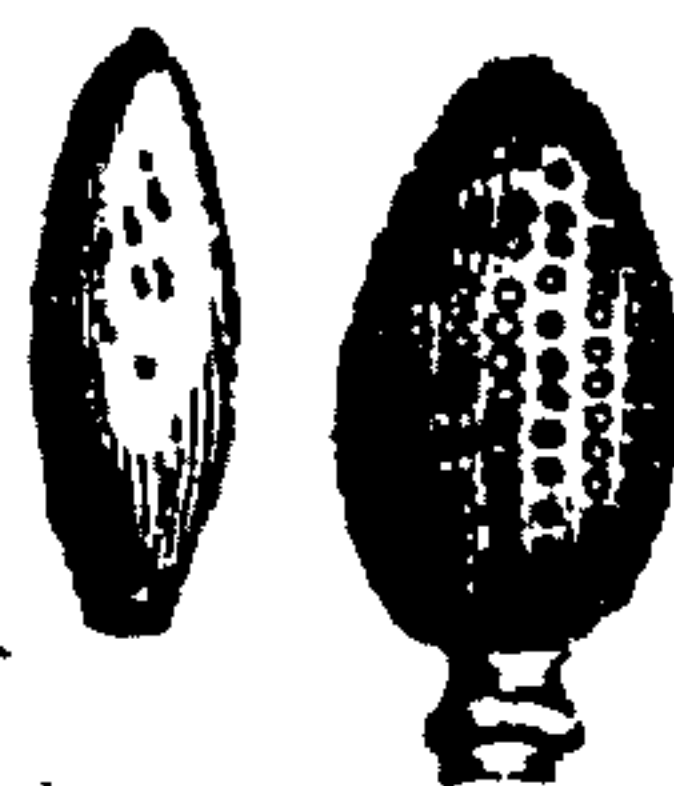


## Class X. Fossil Bodies, once parts of Animals.

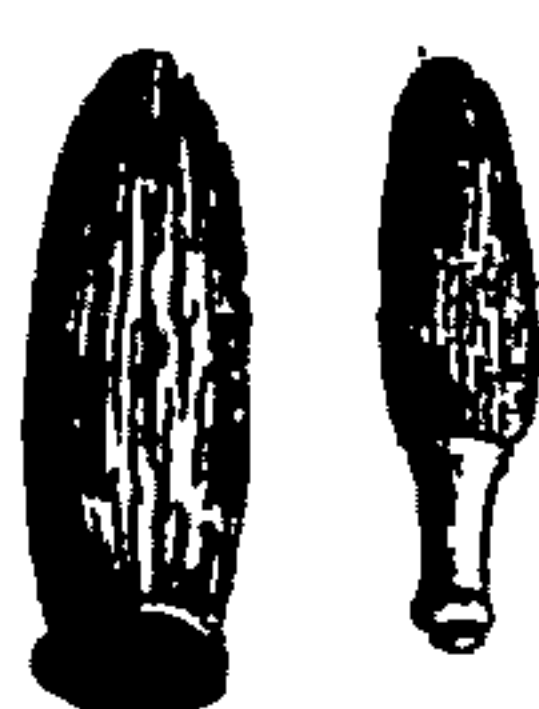
BELEMNITÆ



JUDAICUS



ACULEI



Echinorum.



ENTROCHUS



T R O C H I T Æ



ASTEROPodium cum Asteria.



APPENDICULE Asteriarum.



Asteria or STAR Stones



ASTEROPodium





this not in one country alone, but in all places where there is any digging for marble, chalk, or any other terrestrial matters, that are so compact as to fence off the external injuries of the air, and thus preserve these shells from decay.

These marine substances, so commonly diffused, and so generally to be met with, were for a long time considered by philosophers, as productions, not of the sea, but of the earth. "As we find that spars," said they, "always shoot into peculiar shapes, so these seeming snails, cockles, and muscle-shells, are only sportive forms that nature assumes amongst others of its mineral varieties: they have the shape of fish, indeed, but they have always been terrestrial substances."

With this plausible solution mankind were for a long time content; but upon closer enquiry, they were obliged to alter their opinion. It was found that these shells had, in every respect, the properties of animal and not of mineral nature. They were found exactly of the same weight with their fellow shells upon shore. They answered all the chemical trials in the same manner as sea shells do. Their parts, when dissolved, had the same appearance to view, the same smell and taste. They had the same effects in medicine when inwardly administered; and, in a word, were so exactly conformable to marine bodies, that they had all the accidental concretions growing to them, (such as pearls, corals, and smaller shells) which are found in shells just gathered on the shore. They were, therefore, from these considerations, given back to the sea; but the wonder was, how to account for their coming so far from their own natural element upon land.

As this naturally gave rise to many conjectures, it is not to be wondered that some among them have been very extraordinary. An Italian, quoted by Mr. Buffon, supposes them to have been deposited in the earth at the time of the crusades, by the pilgrims who returned from Jerusalem: who gathering them upon the sea shore, in their return carried them to their different places of habitation. But this conjecturer seems to have but a very inadequate idea of their numbers. At Touraine, in France, more than an hundred miles from the sea, there is a plain of about nine leagues long, and as many broad, from whence the peasants of the country supply themselves with marle for manuring their lands. They seldom dig deeper than twenty feet, and the whole plain is composed of the same materials, which are shells of various kinds, without the smallest portion of earth between them. Here then, is a large space, in which are deposited millions of tons of shells, that pilgrims could not have collected, though their whole employment had been nothing else. England is furnished with its beds, which though not quite so extensive, yet are equally wonderful. "Near Reading in Berkshire, for many succeeding generations, a continued body of oyster-shells has been found through the whole circumference of five or six acres of ground. The foundation of these shells is an hard rocky chalk; and above this chalk, the oyster-shells lie in a bed of green sand, upon a level, as high as can possibly be judged, and about two feet thickness." These shells are in their natural state, but they were found also petrified, and almost in equal abundance in all the Alpine rocks, in the Pyrenees, on the hills of France, England, and Flanders. Even in all quarries from whence marble is dug, if the rocks be split perpendicularly downwards, petrified shells, and other marine substances, will be plainly discerned.

About a quarter of a mile from the river Medway, in the county of Kent, after the taking off the coping of a piece of ground there, the workmen

came to a blue marble, which continued for three feet and a half deep, or more, and then beneath appeared an hard floor or pavement, composed of petrified shells crowded closely together. This layer was about an inch deep, and several yards over; and it could be walked upon as upon a beach. These stones, of which it was composed, (the describer supposes them to have always been stones) were either wreathed as snails, or bivalvular like cockles. The wreathed kinds were about the size of an hazelnut, and were filled with a stony substance of the colour of marle; and they themselves, also, till they were washed, were of the same colour; but when cleaned they appear of the colour of bezoar, and of the same polish. After boiling in water they became whitish, and left a chalkiness upon the fingers."

In several parts of Asia and Africa, travellers have observed these shells in great abundance. In the mountains of Castravan, which lie above the city Barut, they quarry out a white stone, every part of which contains petrified fishes in great numbers, and of surprising diversity. They also seem to continue in such preservation, that their fins, scales, and all the minutest distinctions of their make, can be perfectly discerned.

From all these instances we may conclude, that fossils are very numerous; and, indeed, independent of their situation, they afford no small entertainment to observe them as preserved in the cabinets of the curious. The varieties of their kinds is astonishing. Most of the sea shells which are known, and many others to which we are entirely strangers, are to be seen either in their natural state, or in various degrees of petrefaction. In the place of some we have mere spar, or stone, exactly expressing all the lineaments of animals, as having been wholly formed from them. For it has happened that the shells dissolving by very slow degrees, and the matter having nicely and exactly filled all the cavities within, this matter, after the shells have perished, has preserved exactly and regularly the whole print of their internal surface. Of these there are various kinds found in our pits; many of them resembling those of our own shores; and many others that are only to be found on the coasts of other countries. There are some shells resembling those that are never stranded upon our coasts, but always remain in the deep; and many more there are which we can assimilate with no shells known amongst us. But we find not only shells in our pits, but also fishes and corals in great abundance; together with almost every sort of marine production.

It is extraordinary enough, however, that the common red coral, though so very frequent at sea, is scarce seen in the fossil world; nor is there any account of its having ever been met with. But to compensate for this, there are all the kinds of the white coral now known; and many other kinds of that substance with which we are unacquainted. Of animals there are various parts; the vertebræ of whales, and the mouths of lesser fishes; these, with teeth also of various kinds, are found in the cabinets of the curious; where they receive long Greek names, which it is neither the intention nor the province of this work to enumerate. Indeed, few readers would think themselves much improved, should we proceed with enumerating the various classes of the Conicthyodonts, Polypleptoginglimi, or the Orthoceratites. These names, which mean no great matter when they are explained, may serve to guide in the furnishing a cabinet; but they are of very little service in furnishing the page of instructive history.

From all these instances we see in what abundance petrefactions are to be found; and, indeed, Mr.



Mr. Buffon, has not been sparing in the variety of his quotations, concerning the places where they are mostly to be found. However, we are surpris'd that he should have omitted the mention of one, which, in some measure, more than any of the rest, would have served to strengthen his theory. We are inform'd by almost every traveller, that has described the pyramids of Egypt, that one of them is entirely built of a kind of free-stone, in which these petrified shells are found in great abundance. This being the case, it may be conjectured, as we have accounts of these pyramids among the earliest records of mankind, and of their being built so long before the age of Herodotus, who lived but fifteen hundred years after the flood, that even the Egyptian priests could tell neither the time nor the cause of their erection; therefore it may be conjectured that they were erected but a short time after the flood. It is not very likely, therefore, that the marine substances found in one of them, had time to be formed into a part of the solid stone, either during the deluge, or immediately after it; and, consequently, their petrefaction must have been before that period. And this is the opinion Mr. Buffon has so strenuously endeavoured to maintain; having given specious reasons to prove, that such shells were laid in the beds where they are now found, not only before the deluge, but even antecedent to the formation of man, at the time when the whole earth, as he supposes, was buried beneath a covering of waters.

But while there are many reasons to persuade us that these extraneous fossils have been deposited by the sea, there is one fact that will abundantly serve to convince us that the earth was habitable, if not inhabited, before these marine substances came to be thus deposited; for we find fossil-trees, which no doubt once grew upon the earth, as deep, and as much in the body of solid rocks, as these shells are found to be. Some of these fallen trees also have lain at last as long, if not longer, in the earth, than the shells, as they have been found sunk deep in a marly substance, composed of decayed shells, and other marine productions. Mr. Buffon has proved that fossil-shells could not have been deposited in such quantities all at once by the flood; and we think, from the above instance, it is pretty plain, that howsoever they were deposited, the earth was covered with trees before their deposition; and, consequently, that the sea could not have made a very permanent stay. How then shall we account for these extraordinary appearances in nature? A suspension of all assent is certainly the first, although the most mortifying conduct. Were we to offer a conjecture (and all that has been said upon this subject is but conjecture) instead of supposing them to be the remains of animals belonging to the sea, we would consider them rather as bred in the numerous fresh-water lakes that, in primæval times, covered the face of uncultivated nature. Some of these shells we know to belong to fresh waters: some can be assimilated to none of the marine shells now known; why, therefore, may we not as well ascribe the production of all to fresh waters, where we do not find them, as we do that of the latter to the sea only, where we never find them? We know that lakes, and lands also, have produced animals that are now no longer existing; why, therefore, might not these fossil productions be among the number? We allow that this is making a very harsh supposition; but we cannot avoid thinking, that it is not attended with so many embarrassments as some of the former; and that it is much easier to believe that these shells were bred in fresh water, than that the sea had for a long time covered the tops of the highest mountains.

## CHAP. VI.

## NATURAL HISTORY of the internal Structure of the EARTH.

HAVING, in some measure, got free from the regions of conjecture, let us now proceed to a description of the earth as we find it by examination; and observe its internal composition, as far as it has been the subject of experience, or exposed to human enquiry. These enquiries, indeed, have been carried but to a very little depth below its surface, and even in that disquisition men have been conducted more by motives of avarice than of curiosity. The deepest mine, which is that at Cotteberg in Hungary, reaches not more than three thousand feet deep; but what proportion does that bear to the depth of the terrestrial globe, down to the centre, which is above four thousand miles? All, therefore, that has been said of the earth, to a deeper degree, is merely fabulous or conjectural: we may suppose with Buffon, that it is a globe of glass; with Whiston, a sphere of heated iron; with Burnet, a great mass of waters; and with Kircher, one dreadful volcano; but let us, at the same time, shew our consciousness, that all these are but suppositions.

Upon examining the earth, where it has been opened to any depth, the first thing that occurs, is the different layers or beds of which it is composed; these all lying horizontally one over the other like the leaves of a book, and each of them composed of materials that increase in weight in proportion as they lie deeper. This is, in general, the disposition of the different materials where the earth seems to have remained unmolested; but this order is frequently inverted; and we cannot tell whether from its original formation, or from accidental causes. Of different substances, thus disposed, the far greatest part of our globe consists, from its surface downwards to the greatest depths we ever dig or mine.

The first layer most commonly found at the surface, is that light coat of blackish mould, which is called, by some, garden earth. With this the earth is every where invested, unless it be washed off by rains, or removed by some other external violence. This seems to have been formed from animal and vegetable bodies decaying, and thus turning into its substance. It also serves again as a store-house, from whence animal and vegetable nature are renewed; and thus are all vital blessings continued with unceasing circulation. This earth, however, is not to be supposed entirely pure, but is mixed with much stony and gravelly matter, from the layers lying immediately beneath it. It generally happens, that the soil is fertile in proportion to the quantity that this putrified mould bears to the gravelly mixture; and as the former predominates, so far is the vegetation upon it more luxuriant. It is this external covering that supplies man with all the true riches he enjoys. He may bring up gold and jewels from greater depths; but they are merely the toys of a capricious being, things upon which he has placed an imaginary value, and for which fools alone part with the more substantial blessings of life. It is this earth, says Pliny, that, like a kind mother, receives us at our birth, and sustains us when born. It is this alone, of all the elements around us, that is never found an enemy to man. The body of waters deluge him with rains, oppress him with hail, and drown him with inundations. The air rushes in storms, prepares the tempest, or lights up the volcano; but the earth, gentle and indulgent, ever subservient to the wants of man, spreads his walks with flowers, and his table with plenty;



plenty; returns with interest every good committed to her care; and, though she produces the poison, she still supplies the antidote; though constantly teized more to furnish the luxuries of man than his necessities, yet, even to the last, she continues her kind indulgence, and, when life is over, she piously covers his remains in her bosom.

This external and fruitful layer which covers the earth, is, as was said, in a state of continual change. Vegetables, which are naturally fixed and rooted to the same place, receive their adventitious nourishment from the surrounding earth and water: animals, which change from place to place, are supported by these, or by each other. Both, however, having for a time enjoyed a life adapted to their nature, give back to the earth those spoils, which they had borrowed for a very short space, yet still to be quickened again into fresh existence. But the deposits they make are of very dissimilar kinds, and the earth is very differently enriched by their continuance. Those countries that have for a long time supported men and other animals, having been observed to become every day more barren, while, on the contrary, those desolate places, in which vegetables only are abundantly produced, are known to be possessed of amazing fertility. "In regions which are uninhabited," says Mr. Buffon, "where the forests are not cut down, and where animals do not feed upon the plants, the bed of vegetable earth is constantly increasing. In all woods, and even in those often cut, there is a layer of earth of six or eight inches thick, which has been formed by the leaves, branches and bark, which fall and rot upon the ground. It has frequently been observed on a Roman way which crosses Burgundy for a long extent, that there is a bed of black earth, of more than a foot thick, gathered over the stony pavement, on which several trees, of a very considerable size, are supported. This is found to be nothing else than an earth formed by decayed leaves and branches, which have been converted by time into a black soil. Now as vegetables draw much more of their nourishment from the air and water than they do from the earth, it must follow, that in rotting upon the ground, they must give more to the soil than they have taken from it. Hence, therefore, in woods kept a long time without cutting, the soil below increases to a considerable depth; and such we actually find the soil in those American wilds where the forests have been undisturbed for ages. But it is otherwise where men and animals have long subsisted; for as they make a considerable consumption of wood and plants, both for firing and other uses, they take more from the earth than they return to it: it follows, therefore, that the bed of vegetable earth, in an inhabited country, must be always diminishing; and must, at length, resemble the soil of Arabia Petrea, and other provinces of the East, which having been long inhabited, are now become plains of salt and sand; the fixed salt always remaining while the other volatile parts have flown away."

If from this external surface we descend deeper, and view the earth cut perpendicularly downwards, either in the banks of great rivers, or steepy sea shores; or, going still deeper, if we observe it in quarries or mines, we shall find its layers regularly disposed in their proper order. We must not expect, however, to find them of the same kind or thickness in every place, as they differ in different soils and situations. Sometimes marle is seen to be over sand, and sometimes under it. The most common disposition is, that under the first earth is found gravel or sand, then clay or marle, then chalk or coal, marbles, ores, sands, gravels; and thus an alternation of these substances, each growing more

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dense as it sinks deeper. The clay, for instance, found at the depth of an hundred feet, is usually more heavy than that found not far from the surface. In a well which was dug at Amsterdam, to the depth of two hundred and thirty feet, the following substances were found in succession: seven feet of vegetable earth, nine of turf, nine of soft clay, eight of sand, four of earth, ten of clay, four of earth, ten of sand, two of clay, four of white sand, one of soft earth, fourteen of sand, eight of clay mixed with sand, four of sea-sand mixed with shells, then an hundred and two feet of soft clay, and then thirty-one feet of sand.

In a well dug at Marly, to the depth of an hundred feet, Mr. Buffon gives us a still more exact enumeration of its layers of earth. Thirteen of a reddish gravel, two of gravel minged with a vitrifiable sand, three of mud or slime, two of marle, four of marly stone, five of marle in dust mixed with vitrifiable sand, six of very fine vitrifiable sand, three of earthy marle, three of hard marle, one of gravel, one of eglantine, a stone of the hardness and grain of marble, one of gravelly marle, one of stony marle, one of a coarser kind of stony marle, two of a coarser kind still, one of vitrifiable sand mixed with fossil shells, two of fine gravel, three of stony marle, one of coarse powdered marle, one of stone, calcinable like marble, three of grey sand, two of white sand, one of red sand streaked with white, eight of grey sand with shells, three of very fine sand, three of a hard grey stone, four of red sand streaked with white, three of white sand, and fifteen of a reddish vitrifiable sand.

In this manner the earth is every where found in beds over beds; and, what is still remarkable, each of them, as far as it extends, always maintains exactly the same thickness. It is found also, that, as we proceed to considerable depths, every layer grows thicker. Thus in the adduced instances we might have observed, that the last layer was fifteen feet thick, while most of the others were not above eight; and this might have gone much deeper, for ought we can tell, as before they got through it the workmen ceased digging.

These layers are sometimes very extensive, and often are found to cover a space of some leagues in circumference. But it must not be supposed that they are uniformly continued over the whole globe without any interruption: on the contrary, they are ever, at small intervals, cracked through as it were by perpendicular fissures; the earth resembling, in this respect, the muddy bottom of a pond, from whence the water has been dried off by the sun, and thus gaping in several chinks, which descend in a direction perpendicular to its surface. These fissures are many times found empty, but oftener closed up with adventitious substances, that the rain, or some other accidental causes, have conveyed to fill their cavities. Their openings are not less different than their contents, some being not above half an inch wide, some a foot, and some several hundred yards asunder; which last form those dreadful chasms that are to be found in the Alps, at the edge of which the traveller stands, dreading to look down at the immeasurable gulph below. These amazing clefts are well known to such as have past these mountains, where a chasm frequently presents itself several hundred feet deep, and as many over, at the edge of which the way lies. It often happens also, that the road leads along the bottom, and then the spectator observes on each side frightful precipices several hundred yards above him; the sides of which correspond so exactly with each other, that they evidently seem torn asunder.

But these chasms to be found in the Alps, are nothing to what Ovalle tells us are to be seen in the

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Andes.



Andes. These amazing mountains, in comparison of which the former are but little hills, have their fissures in proportion to their greatness. In some places they are a mile wide, and deep in proportion; and there are some others, that running under ground, in extent resemble a province.

Of this kind also is that cavern called Elden-hole, in Derbyshire; which, Dr. Plot tells us, was founded by a line of eight and twenty hundred feet, without finding the bottom, or meeting with water: and yet the mouth at the top is not above forty yards over. This immeasurable cavern runs perpendicularly downward; and the sides of it seem to tally so plainly as to shew that they once were united. Those who come to visit the place, generally procure stones to be thrown into its mouth; and these are heard for several minutes, falling and striking against the sides of the cavern, producing a sound that resembles distant thunder, dying away as the stone goes deeper.

Of this kind also is that dreadful cavern described by Ælian; his account of which the reader may not have met with. "In the country of the Arrian Indians, is to be seen an amazing chasm, which is called, The Gulph of Pluto. The depth, and the recesses of this horrid place, are as extensive as they are unknown. Neither the natives, nor the curious who visit it, are able to tell how it first was made, or to what depths it descends. The Indians continually drive thither great multitudes of animals, more than three thousand at a time, of different kinds, sheep, horses, and goats; and, with an absurd superstition, force them into the cavity, from whence they never return. Their several sounds, however, are heard as they descend; the bleating of sheep, the lowing of oxen, and the neighing of horses, issuing up to the mouth of the cavern. Nor do these sounds cease, as the place is continually furnished with a fresh supply."

There are many more of these dreadful perpendicular fissures in different parts of the earth; with accounts of which Kircher, Gassarellus, and others, who have given histories of the wonders of the subterranean world, abundantly supply us. The generality of readers, however, will consider them with less astonishment, when they are informed of their being common all over the earth: that in every field, in every quarry, these perpendicular fissures are to be found; either still gaping, or filled with matter that has accidentally closed their interstices. The inattentive spectator neglects the enquiry, but their being common is partly the cause that excites the philosopher's attention to them: the irregularities of nature he is often content to let pass unexamined; but when a constant and a common appearance presents itself, every return of the object is a fresh call to his curiosity; and the chink in the next quarry becomes as great a matter of wonder as the chasm in Elden-hole. Philosophers have long, therefore, endeavoured to find out the cause of these perpendicular fissures, which our own countrymen, Woodward and Ray, were the first that found to be so common and universal. Mr. Buffon supposes them to be cracks made by the sun, in drying up the earth immediately after its emerfion from the deep. The heat of the sun is very probably a principal cause; but it is not right to ascribe to one only, what we find may be the result of many. Earthquakes, severe frosts, bursting waters, and storms tearing up the roots of trees, have, in our own times, produced them: and to this variety of causes we must, at present, be content to assign those that have happened before we had opportunities for observation.

## C H A P. VII.

Of CAVES and Subterraneous PASSAGES that sink, but not perpendicularly, into the Earth.

**W**HEN we survey the subterrenean wonders of the globe, besides those fissures that descend perpendicularly, we frequently find others that descend but a little way, and then spread themselves often to a great extent below the surface. Many of these caverns, it must be confessed, may be the production of art and human industry; retreats made to protect the oppressed, or shelter the spoiler. The famous labyrinth of Candia, for instance, is supposed to be entirely the work of art. Mr. Tournefort assures us, that it bears the impression of human industry, and that great pains have been bestowed upon its formation. The stone-quarry of Maestricht is evidently made by labour: carts enter at its mouth, and load within, then return and discharge their freight into boats that lie on the brink of the river Maese. This quarry is so large, that forty thousand people may take shelter in it: and it in general serves for this purpose, when armies march that way; becoming then an impregnable retreat to the people that live thereabout. Nothing can be more beautiful than this cavern, when lighted up with torches; for there are thousands of square pillars, in large level walks, about twenty feet high; and all wrought with much neatness and regularity. In this vast grotto there is very little rubbish; which shews both the goodness of the stone, and the carefulness of the workmen. To add to its beauty, there also are, in various parts of it, little pools of water, for the convenience of the men and cattle. It is remarkable also, that no droppings are seen to fall from the roof, nor are the walks any way wet under foot, except in cases of great rains, where the water gets in by the air shafts. The Salt-mines in Poland are still more spacious than these. Some of the catacombs, both in Egypt and Italy, are said to be very extensive. But no part of the world has a greater number of artificial caverns than Spain, which were made to serve as retreats to the Christians, against the fury of the Moors, when the latter conquered that country. However, an account of the works of art does not properly belong to a natural history. It will be sufficient to observe, that though caverns be found in every country, far the greatest part of them have been fashioned by the hand of Nature only. Their size is found beyond the power of man to have effected; and their forms but ill adapted to the conveniences of an human habitation. In some places, indeed, we find mankind still make use of them as houses; particularly in those countries where the climate is very severe; but in general they are deserted by every race of meaner animals, except the bat: these nocturnal solitary creatures are usually the only inhabitants; and these only in such whose descent is sloping, or, at least, not directly perpendicular.

There is scarce a country in the world without its natural caverns; and many new ones are discovered every day. Of those in England, Oakey-hole, the Devil's-hole, and Penpark-hole, have been often described. The former, which lies on the south side of Mendip-hills, within a mile of the town of Wells, is much resorted to by travellers. To conceive a just idea of this, we must imagine a precipice of more than an hundred yards high, on the side of a mountain which shelves away a mile above it. In this is an opening not very large, into which you enter, going along upon a rocky uneven pavement, sometimes ascending, and sometimes descending. The roof of it, as you advance,

grows



grows higher; and, in some places, is fifty feet from the floor. In some places, however, it is so low that a man must stoop to pass. It extends itself, in length, about two hundred yards; and from every part of the roof, and the floor, there are formed sparry concretions of various figures, that by strong imaginations have been likened to men, lions, and organs. At the farthest part of this cavern rises a stream of water, well stored with fish, large enough to turn a mill, and which discharges itself near the entrance.

Penpark-hole, in Gloucestershire, is almost as remarkable as the former. Captain Sturmeý descended into this by a rope, twenty-five fathoms perpendicular, and at the bottom found a very large vault in the shape of an horse-shoe. The floors consisted of a kind of white stone enamelled with lead ore, and the pendent rocks were glazed with spar. Walking forward on this stony pavement, for some time, he came to a great river, twenty fathoms broad, and eight fathoms deep; and having been informed that it ebbed and flowed with the sea, he remained in his gloomy abode for five hours, to make an exact observation. He did not find, however, any alteration whatsoever in its appearance. But his curiosity was ill requited; for it cost this unfortunate gentleman his life: immediately after his return, he was seized with an unusual and violent head-ach, which threw him into a fever, of which he died soon after.

But of all the subterraneous caverns now known, the grotto of Antiparos is the most remarkable, as well for its extent, as for the beauty of its sparry incrustations. This celebrated cavern was first discovered by one Magni, an Italian traveller, about an hundred years ago, at Antiparos, an inconsiderable island of the Archipelago. The account he gives of it is long and inflated, but upon the whole amusing. "Having been informed," says he, "by the natives of Paros, that in the little island of Antiparos, which lies about two miles from the former, of a gigantic statue that was to be seen at the mouth of a cavern in that place, it was resolved that we (the French consul and himself) should pay it a visit. In pursuance of this resolution, after we had landed on the island, and walked about four miles through the midst of beautiful plains, and sloping woodlands, we at length came to a little hill, on the side of which yawned a most horrid cavern, that with its gloom at first struck us with terror, and almost repressed curiosity. Recovering the first surprise, however, we entered boldly; and had not proceeded above twenty paces, when the supposed statue of the giant presented itself to our view. We quickly perceived, that what the ignorant natives had been terrified at as a giant, was nothing more than a sparry concretion, formed by the water dropping from the roof of the cave, and by degrees hardening into a figure that their fears had formed into a monster. Incited by this extraordinary appearance, we were induced to proceed still farther, in quest of new adventures in this subterranean abode. As we proceeded, new wonders offered themselves; the spars, formed into trees and shrubs, presented a kind of petrified grove; some white, some green; and all receding in due perspective. They struck us with the more amazement, as we knew them to be mere productions of Nature, who, hitherto in solitude, had, in her playful moments, dressed the scene, as if for her own amusement.

"But we had as yet seen but a few of the wonders of the place; and we are introduced only into the portico of this amazing temple. In one corner of this half illuminated recess, there appeared an opening of about three feet wide, which seemed to lead to a place totally dark, and that one of the

natives assured us contained nothing more than a reservoir of water. Upon this we tried, by throwing down some stones, which rumbling along the sides of the descent for some time, the sound seemed at last quashed in a bed of water. In order, however, to be more certain, we sent in a Levantine mariner, who, by the promise of a good reward, with a flambeaux in his hand, ventured into this narrow aperture. After continuing within it for about a quarter of an hour, he returned, carrying some beautiful pieces of white spar in his hand, which art could neither imitate nor equal. Upon being informed by him that the place was full of these beautiful incrustations, I ventured in once more with him, for about fifty paces, anxiously and cautiously descending by a steep and dangerous way. Finding, however, that we came to a precipice which led into a spacious amphitheatre, if I may so call it, still deeper than any other part, we returned, and being provided with a ladder, flambeaux, and other things to expedite our descent, our whole company, man by man, ventured into the same opening, and descending one after another, we at last saw ourselves all together in the most magnificent part of the cavern.

"Our candles being now all lighted up, and the whole place completely illuminated, never could the eye be presented with a more glittering, or a more magnificent scene. The roof all hung with solid icicles, transparent as glass, yet solid as marble. The eye could scarce reach the lofty and noble ceiling; the sides were regularly formed with spars; and the whole presented the idea of a magnificent theatre, illuminated with an immense profusion of lights. The floor consisted of solid marble; and in several places magnificent columns, thrones, altars, and other objects appeared, as if nature had designed to mock the curiosities of art. Our voices, upon speaking or singing, were redoubled to an astonishing loudness; and upon the firing of a gun, the noise and reverberations were almost deafening. In the midst of this grand amphitheatre rose a concretion of about fifteen feet high, that, in some measure, resembled an altar; from which, taking the hint, we caused mass to be celebrated there. The beautiful columns that shot up round the altar, appeared like candlesticks; and many other natural objects represented the customary ornaments of this sacrament.

"Below even this spacious grotto, there seemed another cavern; down which I ventured with my former mariner, and descended about fifty paces by means of a rope. I at last arrived at a small spot of level ground, where the bottom appeared different from that of the amphitheatre, being composed of soft clay, yielding to the pressure, and in which I thrust a stick to about six feet deep. In this, however, as above, numbers of the most beautiful chrystals were formed; one of which, particularly, resembled a table. Upon our egress from this amazing cavern, we perceived a Greek inscription upon a rock at the mouth, but so obliterated by time, that we could not read it. It seemed to import that one Antipater, in the time of Alexander, had come thither; but whether he penetrated into the depths of the cavern, he does not think fit to inform us."

Such is the account of this beautiful scene, as communicated in a letter to Kircher. We have another, and a more copious description of it by Tournefort, which is in every body's hands; but we have given the above, both because it was communicated by the first discoverer, and because it is a simple narrative of facts, without any reasoning upon them. According to Tournefort's account, indeed, we might conclude, from the rapid growth of the spars in this grotto, that it must every year be



be growing narrower, and that it must, in time, be choaked up with them entirely; but no such thing has happened hitherto, and the grotto at this day continues as spacious as we ever knew it.

This is not a place for an enquiry into the seeming vegetation of those stony substances with which this and almost every cavern are incrustated. It is enough to observe, in general, that they are formed by an accumulation of that little gritty matter which is carried thither by the waters, and which in time acquires the hardness of marble. What in this place more imports us to know is, how these amazing hollows in the earth came to be formed. In the three instances above-mentioned, it is pretty evident, that their excavation has been owing to water. These finding subterraneous passages under the earth, and by long degrees hollowing the beds in which they flowed, the ground above them has split down closer to their surface, leaving the upper layers of the earth or stone still suspended. The ground that sinks upon the face of the waters forming the floor of the cavern; the ground, or rock that keeps suspended, forming the roof: and, indeed, there are but few of these caverns found without water, either within them, or near enough to point out their formation.

#### C H A P. VIII.

#### Of MINES, DAMPS, and Mineral VAPOURS.

THE caverns, which we have been describing, generally carry us but a very little way below the surface of the earth. Two hundred feet, at the utmost, is as much as the lowest of them is found to sink. The perpendicular fissures run much deeper; but few persons have been bold enough to venture down to their deepest recesses: and some few who have tried, have been able to bring back no tidings of the place, for unfortunately they left their lives below. The excavations of art have conducted us much farther into the bowels of the globe. Some mines in Hungary are known to be a thousand yards perpendicular downwards; and we have been informed, by good authority, of a coal mine in the north of England, an hundred yards deeper still.

It is beside our present purpose to enquire into the peculiar construction and contrivance of these, which more properly belongs to the history of fossils. It will be sufficient to observe in this place, that as we descend into the mines, the various layers of earth are seen, as we have already described them; and in some of these are always found the metals or minerals, for which the mine has been dug. Thus frequently gold is found dispersed and mixed with clay and gravel; sometimes it is mingled with other metallic bodies, stones, or bitumens; and sometimes united with that most obstinate of all substances, platina, from which scarce any art can separate it. Silver is sometimes found quite pure, sometimes mixed with other substances and minerals. Copper is found in beds mixed with various substances, marbles, sulphurs, and pyrites. Tin, the ore of which is heavier than that of any other metal, is generally found mixed with every kind of matter: lead is also equally common; and iron we well know can be extracted from all the substances upon earth.

The variety of substances which are thus found in the bowels of the earth, in their native state, have a very different appearance from what they are afterwards taught to assume by human industry. The richest metals are very often less glittering and splendid than the most useless marcasites, and the basest ores are in general the most beautiful to the eye.

This variety of substances, which compose the

internal parts of our globe, is productive of equal varieties both above and below its surface. The combination of the different minerals with each other, the heats which arise from their mixture, the vapours they diffuse, the fires which they generate, or the colds which they sometimes produce, are all either noxious or salutary to man; so that in this great elaboratory of nature, a thousand benefits and calamities are forging, of which we are wholly unconscious; and it is happy for us that we are so.

Upon our descent into mines of considerable depth, the cold seems to increase from the mouth as we descend; but after passing very low down, we begin, by degrees, to come into a warmer air, which sensibly grows hotter as we go deeper, till, at last, the labourers can scarce bear any covering as they continue working.

This difference in the air was supposed by Boyle to proceed from magazines of fire that lay nearer the centre, and that diffused their heat to the adjacent regions. But we now know that it may be ascribed to more obvious causes. In some mines, the composition of the earth all around is of such a nature, that upon the admission of water or air, it frequently becomes hot, and often bursts out into eruptions. Besides this, as the external air, cannot readily reach the bottom, or be renewed there, and observable heat is perceived below, without the necessity of recurring to the central heat for an explanation.

Hence, therefore, there are two principal causes of the warmth at the bottom of mines: the heat of the substances of which the sides are composed; and the want of renovation in the air below. Any sulphureous substance mixed with iron, produces a very great heat, by the admission of water. If, for instance, a quantity of sulphur be mixed with a proportionable share of iron filings, and both kneaded together into a soft paste, with water, they will soon grow hot, and at last produce a flame. This experiment, produced by art, is very commonly effected within the bowels of the earth by nature. Sulphurs and irons are intimately blended together, and want only the mixture of water or air to excite their heat; and this, when once raised, is communicated to all bodies that lie within the sphere of their operation. Those beautiful minerals called marcasites and pyrites, are often of this composition; and wherever they are found, either by imbibing the moisture of the air, or having been by any means combined with water, they render the mine considerably hot.

The want of fresh air, also, at these depths, is, as we have said, another reason for their being found much hotter. Indeed, without the assistance of art, the bottom of most mines would, from this cause, be insupportable. To remedy this inconvenience, the miners are often obliged to sink, at some convenient distance from the mouth of the pit where they are at work, another pit, which joins the former below, and which, in Derbyshire, is called an air-shaft. Through this the air circulates; and thus the workmen are enabled to breathe freely at the bottom of the place; which becomes, as Mr. Boyle affirms, very commodious for respiration; and also very temperate as to heat and cold. Mr. Locke, however, who has left us an account of the Mendip mines, seems to present a different picture. "The descent into these is exceeding difficult and dangerous; for they are not sunk like wells, perpendicularly, but as the crannies of the rocks happen to run. The constant method is to swing down by a rope, placed under the arms, and clamber along, by applying both feet and hands to the sides of the narrow passage. The air is conveyed into them through a little passage that runs along the sides from the top, where they set up some turfs, on the lee-side of the hole, to catch and force it down. These turfs being removed to the windy side, or laid over the



the mouth of the hole, the miners below presently want breath, and faint; and if sweet-smelling flowers chance to be placed there, they immediately lose their fragrantcy, and stink like carrion." An air so very putrifying can never be very commodious for respiration.

Indeed, if we examine the complexion of most miners, we shall be very well able to form a judgment of the unwholesomeness of the place where they are confined. Their pale and fallow looks shew how much the air is damaged by passing through those deep and winding ways, that are rendered humid by damps, or warmed with noxious exhalations. But although every mine is unwholesome, all are not equally so. Coal-mines are generally less noxious than those of tin; tin than those of copper; but none are so dreadfully destructive as those of quicksilver. At the mines near the village of Idra, nothing can adequately describe the deplorable infirmities of such as fill the hospital there: emaciated and crippled, every limb contracted or convulsed, and some in a manner transpiring quicksilver at every pore. There was one man, says Dr. Pope, who was not in the mines above half a year, and yet whose body was so impregnated with this mineral, that putting a piece of brass money in his mouth, or rubbing it between his fingers, it immediately became as white as if it had been washed over with quicksilver. In this manner all the workmen are killed sooner or later; first becoming paralytic, and then dying consumptive: and all this they sustain for the trifling reward of seven-pence a day.

But these metallic mines are not so noxious from their own vapours, as from those of the substances with which the ores are usually united, such as arsenic, cinnabar, bitumen, or vitriol. From the fumes of these, variously combined, and kept enclosed, are produced those various damps that put on so many dreadful forms, and are usually so fatal. Sometimes those noxious vapours are perceived by the delightful fragrance of their smell, somewhat resembling the pea-blossom in bloom, from whence one kind of damp has its name. The miners are not deceived, however, by its flattering appearances; but as they have thus timely notice of its coming, they avoid it while it continues, which is generally during the whole summer season. Another shews its approach by the burning of the candles, which seem to collect their flame into a globe of light, and thus gradually lessen, till they are quite extinguished. From this also the miners frequently escape; however, such as have the misfortune to be caught in it; either swoon away, and are suffocated, or slowly recover in excessive agonies. Here also is a third, called the fulminating damp, much more dangerous than either of the former, as it strikes down all before it, like a flash of gunpowder, without giving any warning of its approach. But there is another, more dangerous than all the rest, which is found in those places where the vapour has been long confined, and has been, by some accident, set free. The air rushing out from thence, always goes upon deadly errands; and scarce any escape to describe the symptoms of its operations.

Some colliers in Scotland, working near an old mine that had been long closed up, happened inadvertently to open an hole into it, from the pit where they were then employed; luckily they at that time perceived their error, and instantly fled for their lives. The next day, however, they were resolved to renew their work in the same pit; and eight of them ventured down, without any great apprehensions; but they had scarce got to the bottom of the stairs that led to the pit, but coming within the vapour, they all instantly dropped down dead, as if they had been shot. Amongst these unfortunate

poor men, there was one whose wife was informed that he was stifled in the mine; and as he happened to be next the entrance, she so far ventured down as to see where he lay. As she approached the place, the sight of her husband inspired her with a desire to rescue him, if possible, from that dreadful situation; though a little reflection might have shewn her it was then too late. But nothing could deter her; she ventured forward, and had scarce touched him with her hand, when the damp prevailed, and the misguided, but faithful creature, fell dead by his side.

Thus, the vapours found beneath the surface of the earth, are very various in their effects upon the constitution: and their are not less in their appearances. There are many kinds that seemingly are no way prejudicial to health, but in which the workmen breathe freely; and yet in these, if a lighted candle be introduced, they immediately take fire, and the whole cavern at once becomes one furnace of flame. In mines, therefore, subject to damps of this kind, they are obliged to have recourse to a very peculiar contrivance to supply sufficient light for their operations. This is by a great wheel; the circumference of which is beset with flints, which striking against steels placed for that purpose at the extremity, a stream of fire is produced, which affords light enough; and yet which does not set fire to the mineral vapour.

Of this kind are the vapours of the mines about Bristol: on the contrary, in other mines a single spark struck out from the collision of flint and steel, would set the whole shaft in a flame. In such, therefore, every precaution is used to avoid a collision; the workmen making use only of wooden instruments in digging; and being cautious before they enter the mine, to take out even the nails from their shoes. Whence this strange difference should arise, that the vapours of some mines catch fire with a spark, and others only with a flame, is a question that we must be content to leave in obscurity, till we know more of the nature both of mineral vapour and of fire. This only we may observe, that gunpowder will readily fire with a spark, but not with the flame of a candle: on the other hand, spirits of wine will flame with a candle, but not with a spark; but even here the cause of this difference, as yet, remains a secret.

As from this account of mines, it appears that the internal parts of the globe are filled with vapours of various kinds, it is not surprising, that they should at different times reach the surface, and there put on various appearances. In fact, much of the salubrity, and much of the unwholesomeness of climates and soils, is to be ascribed to these vapours, which make their way from the bowels of the earth upwards, and refresh or taint the air with their exhalations. Salt mines being naturally cold, send forth a degree of coldness to the external air, to comfort and refresh it: on the contrary, metallic mines are known, not only to warm it with their exhalations, but often to destroy all kinds of vegetation by their volatile corrosive fumes. In some mines dense vapours are plainly perceived issuing from their mouths, and sensibly warm to the touch. In some places, neither snow nor ice will continue on the ground that covers a mine; and over others the fields are found destitute of verdure. The inhabitants, also, are rendered dreadfully sensible of these subterraneous exhalations, being affected with such a variety of evils proceeding entirely from this cause, that books have been professedly written upon this class of disorders.

Nor are these vapours which thus escape to the surface of the earth, entirely unconfined; for they are frequently, in a manner circumscribed to a spot: the grotto Del Cane, near Naples, is an instance of this;



this; the noxious effects of which have made that cavern so very famous. This grotto, which has so much employed the attention of travellers, lies within four miles of Naples, and is situated near a large lake of clear and wholesome water. Nothing can exceed the beauty of the landscape which this lake affords; being surrounded with hills covered with forests of the most beautiful verdure, and the whole bearing a kind of amphitheatrical appearance. However, this region, beautiful as it appears, is almost entirely uninhabited; the few peasants that necessity compels to reside there, looking quite consumptive and ghastly, from the poisonous exhalations that rise from the earth. The famous grotto lies on the side of an hill, near which place a peasant resides, who keeps a number of dogs for the purpose of shewing the experiment to the curious. These poor animals always seem perfectly sensible of the approach of a stranger, and endeavour to get out of the way. However, their attempts being perceived, they are taken and brought to the grotto; the noxious effects of which they have so frequently experienced. Upon entering this place, which is a little cave, or rather a hole dug into the hill, about eight feet high and twelve feet long, the observer can see no visible marks of its pestilential vapour; only to about a foot from the bottom, the wall seems to be tinged with a colour resembling that which is given by stagnant waters. When the dog, this poor philosophical martyr, as some have called him, is held above this mark, he does not seem to feel the smallest inconvenience; but when his head is thrust down lower, he struggles to get free for a little; but in the space of four or five minutes he seems to lose all sensation, and to be taken out without life. Being plunged in the neighbouring lake, he quickly recovers, and is permitted to run home seemingly without the smallest injury.

This vapour, which thus for a time suffocates, is of the humid kind, as it extinguishes a torch, and sullies a looking-glass: but there are other vapours perfectly inflammable, and that only require the approach of a candle to set them blazing. Of this kind was the burning well at Brosely, which is now stopped up; the vapour of which, when a candle was brought within about a foot of the surface of the water, caught flame like spirits of wine, and continued blazing for several hours after. Of this kind, also, are the perpetual fires in the kingdom of Persia. In that province, where the worshippers of fire hold their chief mysteries, the whole surface of the earth, for some extent, seems impregnated with inflammable vapours. A reed struck into the ground continues to burn like a flambeau; an hole made beneath the surface of the earth, instantly becomes a furnace answering all the purposes of a culinary fire. There they make lime by merely burying the stones in the earth, and watch with veneration the appearances of a flame that has not been extinguished for times immemorial. How different are men in various climates! This deluded people worship these vapours as a deity, which in other parts of the world are considered as one of the greatest evils.

## CHAP. IX.

### OF VOLCANOES and EARTHQUAKES.

**M**INES and caverns, as we have said, reach but a very little way under the surface of the earth, and we have hitherto had no opportunities of exploring further. Without all doubt the wonders that are still unknown surpass those that have been represented, as there are depths of thousands of miles which are hidden from our enquiry. The

only tidings we have from those unfathomable regions are by means of volcanoes, those burning mountains that seem to discharge their materials from the lowest abysses of the earth. A volcano may be considered as a cannon of immense size, the mouth of which is often near two miles in circumference. From this dreadful aperture are discharged torrents of flame and sulphur, and rivers of melted metal. Whole clouds of smoke and ashes, with rocks of enormous size, are discharged to many miles distance; so that the force of the most powerful artillery is but as a breeze agitating a feather, in comparison. In the deluge of fire and melted matter which runs down the sides of the mountain, whole cities are sometimes swallowed up and consumed. Those rivers of liquid fire are often two hundred feet deep; and, when they harden, frequently form considerable hills. Nor is the danger of these confined to the eruption only: but the force of the internal fire struggling for vent, frequently produces earthquakes through the whole region where the volcano is situated. So dreadful have been these appearances, that men's terrors have added new horrors to the scene, and they have regarded as prodigies, what we know to be the result of natural causes. Some philosophers have considered them as vents communicating with the fires of the centre, and the ignorant as the mouths of hell itself. Astonishment produces fear, and fear superstition: the inhabitants of Iceland believe the bellowings of Hecla are nothing else but the cries of the damned, and that its eruptions are contrived to encrease their tortures.

But if we regard this astonishing scene of terror with a more tranquil and inquisitive eye, we shall find that these conflagrations are produced by very obvious and natural causes. We have already been apprized of the various mineral substances in the bosom of the earth, and their aptness to burst out into flames. Marcasites and pyrites, in particular, by being humidified with water, or air, contract this heat, and often endeavour to expand with irresistible explosion. These, therefore, being lodged in the depths of the earth, or in the bosom of mountains, and being either washed by the accidental influx of waters below, or fanned by air, insinuating itself through perpendicular fissures from above, take fire at first by only heaving in earthquakes, but at length by bursting through every obstacle, and making their dreadful discharge in a volcano.

These volcanoes are found in all parts of the earth: in Europe there are three that are very remarkable; *Ætna* in Sicily, *Vesuvius* in Italy, and *Hecla* in Iceland. *Ætna* has been a volcano for ages immemorial. Its eruption are very violent, and its discharge has been known to cover the earth sixty-eight feet deep. In the year 1537, an eruption of this mountain produced an earthquake through the whole island, for twelve days, overturned many houses, and at last formed a new aperture which overwhelmed all within five leagues round. The cinders thrown up were driven even into Italy; and its burning were seen at Malta, at the distance of sixty leagues. There is nothing more awful, says Kircher, than the eruptions of this mountain, nor nothing more dangerous than attempting to examine its appearances, even long after the eruption has ceased. As we attempt to clamber up its steep sides, every step we take upward, the feet sink back half way. Upon arriving near the summit, ashes and snow, with an ill assorted conjunction, present nothing but objects of desolation. Nor is this the worst, for, as all places are covered over, many caverns are intirely hidden from the sight, into which, if the enquirer happens to fall, he sinks to the bottom and meets inevitable destruction. Upon coming to the edge of the great crater, nothing can sufficiently



ficiently represent the tremendous magnificence of the scene. A gulph two miles over, and so deep that no bottom can be seen; on the sides pyramidical rocks starting out between apertures that emit smoke and flame; all this accompanied with a sound that never ceases, louder than thunder, strikes the bold with horror, and the religious with veneration for him that has power to controul its burnings.

In the descriptions of Vesuvius, or Hecla, we shall find scarce any thing but a repetition of the same terrible objects, though rather lessened, as these mountains are not so large as the former. The crater of Vesuvius is but a mile across, according to the same author; whereas that of *Ætna* is two. On this particular, however, we must place no dependence, as these caverns every day alter; being lessened by the mountains sinking in at one eruption, and enlarged by the fury of another. It is not one of the least remarkable particulars respecting Vesuvius, that Pliny the naturalist was suffocated in one of its eruptions; for his curiosity impelled him too near, he found himself involved in smoke and cinders when it was too late to retire; and his companions hardly escaped to give an account of the misfortune. It was in that dreadful eruption that the city of Herculaneum was overwhelmed; the ruins of which have been lately discovered at sixty feet distance below the surface, and what is still more remarkable, forty feet below the bed of the sea. One of the most remarkable eruptions of this mountain was in the year 1707, which is finely described by Valetta, a part of whose description we beg leave to translate.

"Towards the latter end of summer, in the year 1707, the mount Vesuvius, that had for a long time been silent, now began to give some signs of commotion. Little more than internal murmurs at first were heard, that seemed to contend within the lowest depths of the mountain; no flame, nor even any smoak, was as yet seen. Soon after some smoak appeared by day, and a flame by night, which seemed to brighten all the Campania. At intervals also it shot off substances with a sound very like that of artillery, but which, even at so great a distance as we were at, infinitely exceeded them in greatness. Soon after it began to throw up ashes, which becoming the sport of the winds, fell at great distances, and some many miles. To this succeeded showers of stones, which killed many of the inhabitants of the valley, but made a dreadful ravage among the cattle. Soon after a torrent of burning matter began to roll down the sides of the mountain, at first with a slow and gentle motion, but soon with increased celerity. The matter thus poured out, when cool, seemed, upon inspection, to be of a vitrified earth, the whole united into a mass of more than stony hardness. But what was particularly observable was, that upon the whole surface of these melted materials, a light spongy stone seemed to float, while the lower body was of the hardest substance, of which our roads are usually made. Hitherto there were no appearances but what had been often remarked before; but on the third or fourth day, seeming flashes of lightning were shot forth from the mouth of the mountain, with a noise far exceeding the loudest thunder. These flashes, in colour and brightness, resembled what we usually see in tempests, but they assumed a more twisted and serpentine form. After this followed such clouds of smoak and ashes, that the whole city of Naples, in the midst of the day, was involved in nocturnal darkness; and the nearest friends were unable to distinguish each other in this frightful gloom. If any person attempted to stir out without torch-light, he was obliged to return, and every part of the city was filled with supplica-

tions and terror; at length after a continuance of some hours, about one o'clock at midnight, the wind blowing from the north, the stars began to be seen; the heavens, though it was night, began to grow brighter; and the eruptions, after a continuance of fifteen days, to lessen. The torrent of melted matter was seen to extend from the mountain down to the shore; the people began to return to their former dwellings, and the whole face of nature to resume its former appearance."

Bishop Berkley gives an account of one of these eruptions in a manner something different from the former. "In the year 1717, and the middle of April, with much difficulty I reached the top of mount Vesuvius, in which I saw a vast aperture full of smoak, which hindered me from seeing its depth and figure. I heard within that horrid gulph certain extraordinary sounds, which seemed to proceed from the bowels of the mountain, a sort of murmuring, sighing, dashing sound, and between whiles a noise like that of thunder or cannon, with a clattering like that of tiles falling from the tops of houses into the streets. Sometimes, as the wind changed, the smoak grew thinner, discovering a very ruddy flame, and the circumference of the crater streaked with red and several shades of yellow. After an hour's stay, the smoak being moved by the wind, gave us short and partial prospects of the great hollow; in the flat bottom of which I could discern two furnaces almost contiguous; that on the left seeming about three yards over, glowing with ruddy flame, and throwing up red hot stones, with an hideous noise, which, as they fell back, caused the clattering already taken notice of. May 8, in the morning, I ascended the top of Vesuvius a second time, and found a different face of things. The smoak ascending upright, gave a full prospect of the crater, which, as I could judge, was about a mile in circumference, and an hundred yards deep. A conical mount had been formed since my last visit in the middle of the bottom, which I could see was made by the stones, thrown up and fallen back again into the crater. In this new hill remained the two furnaces already mentioned. The one was seen to throw up every three or four minutes, with a dreadful sound, a vast number of red hot stones, at least three hundred feet higher than my head, as I stood upon the brink; but as there was no wind, they fell perpendicularly back from whence they had been discharged. The other was filled with red hot liquid matter, like that in the furnace of a glass-house; raging and working like the waves of the sea, with a short abrupt noise. This matter would sometimes boil over, and run down the side of the conical hill, appearing at first red hot, but changing colour as it hardened and cooled. Had the wind driven in our faces, we had been in no small danger of stifling by the sulphureous smoak, or being killed by the masses of melted minerals, that were shot from the bottom. But as the wind was favourable, I had an opportunity of surveying this amazing scene for above an hour and an half together. On the fifth of June, after an horrid noise, the mountain was seen at Naples to work over; and about three days after, its thunders were renewed so, that not only the windows in the city, but all the houses shook. From that time it continued to overflow, and sometimes at night were seen columns of fire shooting upward from its summit. On the tenth, when all was thought to be over, the mountain again renewed its terrors, roaring and raging most violently. One cannot form a juster idea of the noise, in the most violent fits of it, than by imagining a mixed sound, made up of the raging of a tempest, the murmur of a troubled sea, and the roaring of thunder and artillery, confused all together. Though we heard this at the distance of twelve



twelve miles, yet it was very terrible. I therefore resolved to approach nearer to the mountain; and, accordingly, three or four of us got into a boat, and were set ashore at a little town, situated at the foot of the mountain. From thence we rode about four or five miles, before we came to the torrent of fire that was descending from the side of the volcano; and here the roaring grew exceeding loud and terrible as we approached. I observed a mixture of colours in the cloud, above the crater, green, yellow, red, blue. There was likewise a ruddy dismal light in the air, over that tract where the burning river flowed. These circumstances, set off and augmented by the horror of the night, made a scene the most uncommon and astonishing I ever saw; which still increased as we approached the burning river. Imagine a vast torrent of liquid fire, rolling from the top, down the side of the mountain, and with irresistible fury bearing down and consuming vines, olives, and houses; and divided into different channels, according to the inequalities of the mountain. The largest stream seemed half a mile broad at least, and five miles long. I walked so far before my companions up the mountain, along the side of the river of fire, that I was obliged to retire in great haste, the sulphurous steam having surprised me, and almost taken away by breath. During our return, which was about three o'clock in the morning, the roaring of the mountain was heard all the way, while we observed it throwing up huge spouts of fire and burning stones, which falling, resembled the stars in a rocket. Sometimes I observed two or three distinct columns of flame, and sometimes one only that was large enough to fill the whole crater. These burning columns, and fiery stones, seemed to be shot a thousand feet perpendicular above the summit of the volcano: and in this manner the mountain continued raging for six or eight days after. On the eighteenth of the same month the whole appearance ended, and the mountain remained perfectly quiet, without any visible smoke or flame."

The matter which is found to roll down from the mouth of all volcanoes in general, resembles the dross that is thrown from a smith's forge. But it is different, perhaps, in various parts of the globe; for, as we have already said, there is not a quarter of the world that has not its volcanoes. In Asia, particularly in the islands of the Indian ocean, there are many. One of the most famous is that of Albours, near Mount Taurus, the summit of which is continually on fire, and covers the whole adjacent country with ashes. In the island of Ternate there is a volcano, which some travellers assert, burns most furiously in the times of the equinoxes, because of the winds which then contribute to increase the flames. In the Molucca islands there are many burning mountains; they are also seen in Japan, and the islands adjacent; and in Java and Sumatra, as well as in other of the Philippine islands. In Africa there is a cavern, near Fez, which continually sends forth either smoke or flames. In the Cape de Verde islands, one of them, called the Island del Fuego, continually burns; and the Portuguese, who frequently attempted a settlement there, have as often been obliged to desist. The Peak of Teneriffe is, as every body knows, a volcano that seldom desists from eruptions. But of all parts of the earth, America is the place where those dreadful irregularities of nature are the most conspicuous. Vesuvius, and Ætna itself, are but mere fire-works, in comparison to the burning mountains of the Andes; which as they are the highest mountains of the world, so also are they the most formidable for their eruptions. The mountain of Arequipa in Peru, is one of the most celebrated; Callaxa; and Malahallo, are very considerable; but

that of Cotopaxi, in the province of Quito, exceeds any thing we have hitherto read or heard of. The mountain of Cotopaxi, as described by Ulloa, is more than three miles perpendicular from the sea; and it became a volcano at the time of the Spaniards first arrival in that country. A new eruption of it happened in the year 1743, having been some days preceded by a continual roaring in its bowels. The sound of one of these mountains is not like that of the volcanoes in Europe, confined to a province, but is heard at an hundred and fifty miles distance. An aperture was made in the summit of this immense mountain; and three more about equal heights, near the middle of its declivity, which was at that time buried under prodigious masses of snow. The ignited substances ejected on that occasion, mixed with a prodigious quantity of ice and snow, melting amidst the flames, were carried down with such astonishing rapidity, that in an instant the valley from Callo to Latacunga was overflowed; and besides its ravages in bearing down the houses of the Indians, and other poor inhabitants, great numbers of people lost their lives. The river of Latacunga was the channel of this terrible flood; till being too small for receiving such a prodigious current, it overflowed the adjacent country, like a vast lake, near the town, and carried away all the buildings within its reach. The inhabitants retired into a spot of higher ground behind the town, of which those parts which stood within the limits of the current were totally destroyed. The dread of still greater devastations did not subside for three days; during which, the volcano ejected cinders, while torrents of melted ice and snow poured down its sides. The eruption lasted several days, and was accompanied with terrible roarings of the wind, rushing through the volcano still louder than the former rumblings in its bowels. At last all was quiet, neither fire nor smoke to be seen, nor noise to be heard; till, in the ensuing year, the flames again appeared with recruited violence, forcing their passage through several other parts of the mountain, so that in clear nights the flames being reflected by the transparent ice, formed an awfully magnificent illumination.

Such is the appearance and the effect of those fires which proceed from the more inward recesses of the earth; for that they generally come from deeper regions than man has hitherto explored, we cannot avoid thinking, contrary to the opinion of Mr. Buffon, who supposes them rooted but a very little way below the bed of the mountain. We can never suppose, says this great naturalist, that these substances are ejected from any great distance, below, if we only consider the great force already required to fling them up to such vast heights above the mouth of the mountain; if we consider the substances thrown up, which we shall find upon inspection to be the same with those of the mountain below; if we take into our consideration, that air is always necessary to keep up the flame; but, most of all, if we attend to one circumstance, which is, that if these substances were exploded from a vast depth below, the same force required to shoot them up so high, would act against the sides of the volcano, and tear the whole mountain in pieces. To all this specious reasoning, particular answers might easily be given; as that the length of the funnel increases the force of the explosion; that the sides of the funnel are actually often burst with the great violence of the flame; that air may be supposed at depths at least as far as the perpendicular fissures descend. But the best answer is a well-known fact; namely, that the quantity of matter discharged from Ætna alone, is supposed, upon a moderate computation, to exceed twenty times the original bulk of the mountain. The greatest part of Sicily seems covered



covered with its eruptions. The inhabitants of Catania have found, at the distance of several miles, streets and houses, sixty feet deep, overwhelmed by the lava or matter it has discharged. But what is still more remarkable, the walls of these very houses have been built of materials evidently thrown up by the mountain. The inference from all this is very obvious; that the matter thus exploded cannot belong to the mountain itself, otherwise, it would have been quickly consumed; it cannot be derived from moderate depths, since its amazing quantity evinces, that all the places near the bottom must have long since been exhausted; nor can it have any extensive, and, if we may so call it, a superficial spread, for then the country round would be quickly undermined; it must, therefore, be supplied from the deeper regions of the earth; those undiscovered tracts where the Deity performs his wonders in solitude, satisfied with self-approbation!

## CHAP. X. OF EARTHQUAKES.

HAVING given the theory of volcanoes, we have in some measure given also that of earthquakes. They both seem to proceed from the same cause, only with this difference, that the fury of the volcano is spent in the eruption, that of an earthquake spreads wider and acts more fatally by being confined. The volcano only affrights a province, earthquakes have laid whole kingdoms in ruin.

Philosophers have taken some pains to distinguish between the various kinds of earthquakes, such as the tremulous, the pulsative, the perpendicular, and the inclined; but these are rather the distinctions of art than of nature, mere accidental differences arising from the situation of the country or of the cause. If, for instance, the confined fire acts directly under a province or a town, it will heave the earth perpendicularly upward, and produce a perpendicular earthquake. If it acts at a distance, it will raise that tract obliquely, and thus the inhabitants will perceive an inclined one.

Nor does it seem that there is much greater reason for Mr. Buffon's distinction of earthquakes. One kind of which he supposes to be produced by fire in the manner of volcanoes, and confined but to a very narrow circumference. The other kind he ascribes to the struggles of confined air, expanded by heat in the bowels of the earth, and endeavouring to get free. For how do these two causes differ? Fire is an agent of no power whatsoever without air. It is the air, which being at first compressed, and then dilated in a cannon, that drives the ball with such force. It is the air struggling for vent in a volcano, that throws up its contents to such vast heights. In short, it is the air confined in the bowels of the earth, and acquiring elasticity by heat, that produces all those appearances generally ascribed to the operation of fire. When, therefore, we are told that there are two causes of earthquakes, we only learn, that a greater or smaller quantity of heat produces those terrible effects; for air is the only active operator in either.

Some philosophers, however, have been willing to give the air as great a share in producing these terrible efforts as they could; and, magnifying its powers, have called in but a very moderate degree of heat to put it in action. Although experience tells that the earth is full of inflammable materials, and that fires are produced wherever we descend; although it tells us that those countries, where there are volcanoes, are most subject to earthquakes, yet they step out of the way, and so find a new solution.

These only allow but just heat enough to produce the most dreadful phenomena, and backing their assertions with long calculations, give theory an air of demonstration. Mr. Amontons has been particularly sparing of the internal heat in this respect; and has shewn perhaps accurately enough, that a very moderate degree of heat may suffice to give the air amazing powers of expansion.

It is astonishing, however, to trace the progress of a philosophical fancy let loose in imaginary speculations. They run thus: "A very moderate degree of heat may bring the air into a condition capable of producing earthquakes; for the air at the depth of forty-three thousand five hundred and twenty-eight fathom below the surface of the earth, becomes almost as heavy as quicksilver. This, however, is but a very slight depth in comparison of the distance to the centre, and is scarce a seventieth part of the way. The air, therefore, at the centre must be infinitely heavier than mercury, or any body that we know of. This granted, we shall take something more, and say, that it is very probable there is nothing but air at the centre. Now let us suppose this air heated, by some means, even to the degree of boiling water, as we have proved that the density of the air is here very great, its elasticity must be in proportion: an heat, therefore, which at the surface of the earth would have produced but a slight expansive force, must at the centre produce one very extraordinary, and, in short, be perfectly irresistible. Hence this force may with great ease produce earthquakes; and if increased it may convulse the globe; it may (by only adding figures enough to the calculation) destroy the solar system, and even the fixed stars themselves." These reveries generally produce nothing; for as we have often observed, increased calculations, while they seem to tire the memory, give the reasoning faculty perfect repose.

However, as earthquakes are the most formidable ministers of nature, it is not to be wondered that a multitude of writers have been curiously employed in their consideration. Woodward has ascribed the cause to a stoppage of the waters below the earth's surface, by some accident. These being thus accumulated, and yet acted upon by fires, which he supposes still deeper, both contribute to heave up the earth upon their bosom. This he thinks accounts for the lakes of water produced in an earthquake, as well as for the fires that sometimes burst from the earth's surface upon those dreadful occasions. There are others who have supposed that the earth may be itself the cause of its own convulsions. When, say they, the roots or basis of some large tract is worn away by a fluid underneath, the earth sinking therein, its weight occasions a tremour of the adjacent parts, sometimes producing a noise, and sometimes an inundation of water. Not to tire the reader with an history of opinions instead of facts, some have ascribed them to electricity, and some to the same causes that produce thunder.

It would be tedious, therefore, to give all the various opinions that have employed the speculative upon this subject. The activity of the internal heat seems alone sufficient to account for every appearance that attends these tremendous irregularities of nature. To conceive this distinctly, let us suppose at some vast distance under the earth, large quantities of inflammable matter, pyrites, bitumens, and marcasites disposed, and only waiting for the asperion of water, or the humidity of the air, to put their fires in motion; at last, this dreadful mixture arrives; waters find their way into those depths, through the perpendicular fissures; or air insinuates itself through the same minute apertures; immediately new appearances ensue: those substances, which for ages before lay dormant, now conceive



new apparent qualities; they grow hot, produce new air and only want room for expansion. However, the narrow apertures by which the air or water had at first admission, are now closed up; yet as new air is continually generated, and as the heat every moment gives this air new elasticity, it at length bursts, and dilates all round; and, in its struggles to get free, throws all above it into similar convulsions. Thus an earthquake is produced, more or less extensive, according to the depth or the greatness of the cause.

But before we proceed with the causes, let us take a short view of the appearances which have attended the most remarkable earthquakes. By these we shall see how far the theorist corresponds with the historian. The greatest we find in antiquity, is that mentioned by Pliny, in which twelve cities in Asia Minor were swallowed up in one night: he tells us also of another, near the lake Thrasymene, which was not perceived by the armies of the Carthaginians and Romans, that were then engaged near that lake, although it shook the greatest part of Italy. In another place he gives the following account of an earthquake of an extraordinary kind. "When Lucius Marcus, and Sextus Julius, were consuls, there appeared a very strange prodigy of the earth, (as I have read in the books of Ætruscan discipline) which happened in the province of Mutina. Two mountains shocked against each other, approaching and retiring with the most dreadful noise. They, at the same time, and in the midst of the day, appeared to cast forth fire and smoke, while a vast number of Roman knights and travellers from the Æmilian way, stood and continued amazed spectators. Several towns were destroyed by this shock; and all the animals that were near them were killed." In the times of Trajan, the city of Antioch, and a great part of the adjacent country, was buried by an earthquake. About three hundred years after, in the times of Justinian, it was once more destroyed, together with forty thousand inhabitants: and, after an interval of sixty years, the same ill-fated city was a third time overturned, with the loss of not less than sixty thousand souls. In the year 1182, most of the cities of Syria, and the kingdom of Jerusalem, were destroyed by the same accident. In the year 1594, the Italian historians describe an earthquake at Putcoli, which caused the sea to retire two hundred yards from its former bed.

But one of those most particularly described in history, is that of the year 1693; the damages of which were chiefly felt in Sicily, but its motion perceived in Germany, France, and England. It extended to a circumference of two thousand six hundred leagues; chiefly affecting the sea-coasts, and great rivers; more perceivable also upon the mountains than in the vallies. Its motions were so rapid, that those who lay at their length, were tossed from side to side, as upon a rolling billow. The walls were dashed from their foundations; and no less than fifty-four cities, with an incredible number of villages, were either destroyed or greatly damaged. The city of Catania, in particular, was utterly overthrown. A traveller, who was on his way thither, at the distance of some miles, perceived a black cloud, like night, hanging over the place. The sea, all of a sudden, began to roar; Mount Ætna to send forth great spires of flame; and soon after a shock ensued, with a noise as if all the artillery in the world had been at once discharged. Our traveller, being obliged to alight instantly, felt himself raised a foot from the ground; and turning his eyes to the city, he with amazement saw nothing but a thick cloud of dust in the air. The birds flew about astonished; the sun was darkened; the beasts ran howling from the hills; and, although the

shock did not continue above three minutes, yet near nineteen thousand of the inhabitants of Sicily perished in the ruins. Catania, to which city the describer was travelling, seemed the principal scene of ruin; its place only was to be found; and not a footstep of its former magnificence was to be seen remaining.

The earthquake which happened in Jamaica, in 1692, was very terrible, and its description sufficiently minute. "In two minutes time it destroyed the town of Port-Royal, and sunk the houses in a gulph forty fathoms deep. It was attended with an hollow rumbling noise, like that of thunder; and, in less than a minute, three parts of the houses, and their inhabitants, were all sunk quite under water. While they were thus swallowed up on one side of the street or the other, the houses were thrown into heaps; the sand of the street rising like the waves of the sea, lifting up those that stood upon it, and immediately overwhelming them in pits. All the wells discharged their waters with the most vehement agitation. The sea felt an equal share of turbulence, and, bursting over its mounds, deluged all that came in its way. The fissures of the earth were, in some places, so great, that one of the streets appeared twice as broad as formerly. In many places, however, it opened and closed again, and continued this agitation for some time. Of these openings, two or three hundred might be seen at a time; in some whereof the people were swallowed up; in others, the earth closing, caught them by the middle, and thus crushed them instantly to death. Other openings, still more dreadful than the rest, swallowed up whole streets; and others, more formidable, spouted up whole cataracts of water, drowning such as the earthquake had spared. The whole was attended with the most noisome stench; while the thundering of the distant falling mountains, the whole sky overcast with a dusky gloom, and the crash of falling habitations, gave unspeakable horror to the scene. After this dreadful calamity was over, the whole island seemed converted into a scene of desolation; scarce a planter's house was left standing; almost all were swallowed up; houses, people, trees, shared one universal ruin; and, in their places appeared great pools of water, which, when dried up by the sun, left only a plain of barren sand, without any vestige of former inhabitants. Most of the rivers, during the earthquake, were stopt up by the falling in of the mountains; and it was not till after some time that they made themselves new channels. The mountains seemed particularly attacked by the force of the shock; and it was supposed that the principal seat of the concussion was among them. Those who were saved, got on board ships in the harbour; where many remained above two months, the shocks continuing during that interval with more or less violence every day."

As this description seems to exhibit all the appearances that usually make up the catalogue of terrors belonging to an earthquake, we will suppress the detail of that which happened at Lisbon, in our own times, and which is too recent to require a description. In fact, there are few particulars in the accounts of those who were present at that scene of desolation, that we have not more minutely and accurately transmitted to us by former writers, whose narratives we have for that reason preferred. We will, therefore, close this description of human calamities, with the account of the dreadful earthquake at Calabria, in 1638. It is related by the celebrated Father Kircher, as it happened while he was on his journey to visit Mount Ætna, and the rest of the wonders that lie towards the south of Italy. The reader, need scarce be informed, that Kircher is considered, by scholars, as one of the greatest prodigies of learning.

"Having



"Having hired a boat, in company with four more, two friars of the order of St. Francis, and two seculars, we launched, on the twenty-four of March, from the harbour of Messina, in Sicily, and arrived, the same day, at the promontory of Pelorus. Our destination was for the city of Euphæmia, in Calabria, where we had some business to transact, and where we designed to tarry for some time. However, Providence seemed willing to cross our design; for we were obliged to continue for three days at Pelorus, upon account of the weather; and though we often put out to sea, yet we were as often driven back. At length, however, wearied with the delay, we resolved to prosecute our voyage; and, although the sea seemed more than usually agitated, yet we ventured forward. The gulph of Charybdis, which we approached, seemed whirled round in such a manner, as to form a vast hollow verging to a point in the centre. Proceeding onward, and turning my eyes to Ætna, I saw it cast forth large volumes of smoke, of mountainous sizes, which entirely covered the whole island, and blotted out the very shores from my view. This, together with the dreadful noise, and the sulphureous stench, which was strongly perceived, filled me with apprehensions that some more dreadful calamity was impending. The sea itself seemed to wear a very unusual appearance; those who have seen a lake in a violent shower of rain covered all over with bubbles, will conceive some idea of its agitations. My surprize was still encreased by the calmness and serenity of the weather; not a breeze, not a cloud which might be supposed to put all Nature thus into motion. I therefore warned my companions that an earthquake was approaching; and, after some time, making for the shore with all possible diligence, we landed at Tropæa, happy and thankful for having escaped the threatening dangers of the sea.

"But our triumphs at land were of short duration; for we had scarce arrived at the Jesuits College in that city, when our ears were stunned with an horrid sound, resembling that of an infinite number of chariots driven fiercely forward, the wheels rattling, and the thongs cracking. Soon after this, a most dreadful earthquake ensued; so that the whole tract upon which we stood seemed to vibrate, as if we were in the scale of a balance that continued wavering. This motion, however, soon grew more violent; and being no longer able to keep my legs, I was thrown prostrate upon the ground. In the mean time, the universal ruin round me redoubled my amazement. The crash of falling houses, the tottering of towers, and the groans of the dying, all contributed to raise my terror and despair. On every side of me I saw nothing but a scene of ruin; and danger threatening wherever I should fly. I commended myself to God as my last great refuge. At that hour, O how vain was every sublunary happiness! wealth, honour, empire, wisdom, all mere useless sounds, and as empty as the bubbles in the deep. Just standing on the threshold of eternity, nothing but God was my pleasure; and the nearer I approached, I only loved him the more. After some time, however, finding that I remained unhurt, amidst the general concussion, I resolved to venture for safety, and running as fast as I could, reached the shore, but almost terrified out of my reason. I did not search long here till I found the boat in which I had landed, and my companions also, whose terrors were even greater than mine. Our meeting was not of that kind where every one is desirous of telling his own happy escape; it was all silence, and a gloomy dread of impending terrors.

"Leaving this seat of desolation, we prosecuted our voyage along the coast; and the next day came

to Rochetta, where we landed, although the earth still continued in violent agitations. But we were scarce arrived at our inn, when we were once more obliged to return to the boat; and, in about half an hour, we saw the greatest part of the town, and the inn at which we had set up, dashed to the ground, and burying all its inhabitants beneath its ruins.

"In this manner, proceeding onward in our little vessel, finding no safety at land, and yet, from the smallness of our boat, having but a very dangerous continuance at sea, we at length landed at Lopizium, a castle midway between Tropæa and Euphæmia, the city to which, as I said before, we were bound. Here, wherever I turned my eyes, nothing but scenes of ruin and horror appeared; towns and castles levelled to the ground; Strombalo, though at sixty miles distance, belching forth flames in an unusual manner, and with a noise which I could distinctly hear. But my attention was quickly turned from more remote to contiguous danger. The rumbling sound of an approaching earthquake, which we by this time were grown acquainted with, alarmed us for the consequences; it every moment seemed to grow louder, and to approach more near. The place on which we stood now began to shake most dreadfully; so that being unable to stand, my companions and I caught hold of whatever shrub grew next us, and supported ourselves in that manner.

"After some time, this violent paroxysm ceasing, we again stood up, in order to prosecute our voyage to Euphæmia, that lay within sight. In the mean time, while we were preparing for this purpose, I turned my eyes towards the city, but could see only a frightful dark cloud, that seemed to rest upon the place. This the more surprized us, as the weather was so very serene. We waited, therefore, till the cloud was past away: then turning to look for the city, it was totally sunk. Wonderful to tell! nothing but a dismal and putrid lake was seen where it stood. We looked about to find some one that could tell us of its sad catastrophe, but could see none. All was become a melancholy solitude; a scene of hideous desolation. Thus proceeding pensively along, in quest of some human being that could give us some little information, we at length saw a boy sitting by the shore, and appearing, stupified with terror. Of him, therefore, we enquired concerning the fate of the city; but he could not be prevailed on to give us an answer. We entreated him with every expression of tenderness and pity to tell us; but his senses were quite wrapt up in the contemplation of the danger he had escaped. We offered him some victuals, but he seemed to loath the sight. We still, persisted in our offices of kindness; but he only pointed to the place of the city, like one out of his senses; and then running up into the woods, was never heard of after. Such was the fate of the city of Euphæmia: and as we continued our melancholy course along the shore, the whole coast, for the space of two hundred miles, presented nothing but the remains of cities, and men scattered, without an habitation, over the fields. Proceeding thus along, we at length ended our distressful voyage by arriving at Naples, after having escaped a thousand dangers both at sea and land.

We hope the reader will excuse this long translation from a favourite writer, and that the sooner, as it contains some particulars relative to earthquakes, not to be found elsewhere. From the whole of these accounts we may gather, that the most concomitant circumstances are these:

A rumbling sound before the earthquake. This proceeds from the air, or fire, or both, forcing their way through the chasms of the earth, and endeavouring



deavouring to get free, which is also heard in volcanoes.

A violent agitation, or heaving of the sea, sometimes before and sometimes after that at land. This agitation is only a similar effect produced on the waters with that at land, and may be called, for the sake of perspicuity, a sea-quake; and this also is produced by volcanoes.

A spouting up of waters to great heights. It is not easy to describe the manner in which this is performed; but volcanoes also perform the same, Vesuvius being known frequently to eject a vast body of water.

A rocking of the earth to and fro, and sometimes a perpendicular bouncing, if it may be so called, of the same. This difference chiefly arises from the situation of the place with respect to the subterranean fire. Directly under it lifts; at a farther distance, it rocks.

Some earthquakes seem to travel onward, and are felt in different countries at different hours the same day. This arises from the great shock being given to the earth at one place, and that being communicated onward by an undulatory motion, successively affects different regions in its progress; as the blow given by a stone falling in a lake is not perceived at the shores till some time after the first concussion.

The shock is sometimes instantaneous, like the explosion of gunpowder; and sometimes tremulous, and continuing for several minutes. The nearer the place where the shock is first given, the more instantaneous and simple it appears. At a greater distance the earth redoubles the first blow, with a sort of vibratory continuation.

As waters have generally so great a share in producing earthquakes, it is not to be wondered that they should generally follow those breaches made by the force of fire, and appear in the great chasms which the earthquake has opened.

These are some of the most remarkable phenomena of earthquakes, presenting a frightful assemblage of the most terrible effects of air, earth, fire, and water.

The valley of Solfatara, near Naples, seems to exhibit, in a minuter degree, whatever is seen of this horrible kind on the great theatre of Nature. This plain, which is about twelve hundred feet long, and a thousand broad, is embosomed in mountains, and has in the middle of it a lake of noisome blackish water, covered with a bitumen, that floats upon its surface. In every part of this plain, caverns appear smoking with sulphur, and often emitting flames. The earth, wherever we walk over it, trembles beneath the feet. Noises of flames, and the hissing of waters, are heard at the bottom. The water sometimes spouts up eight or ten feet high. The most noisome fumes, foetid water, and sulphureous vapours, offend the smell. A stone thrown into any of the caverns, is ejected again with considerable violence. These appearances generally prevail when the sea is any way disturbed; and the whole seems to exhibit the appearance of an earthquake in miniature. However, in this smaller scene of wonders, as well as in the greater, there are many appearances for which perhaps we shall never account; and many questions may be asked, which no conjectures can thoroughly resolve. It was the fault of the philosophers of the last age, to be more inquisitive after the causes of things, than after the things themselves. They seemed to think that a confession of ignorance cancelled their claims to wisdom: they, therefore, had a solution for every demand. But the present age has grown, if not more inquisitive, at least more modest; and none are now ashamed of that ignorance which labour can neither remedy nor remove.

## CHAP. XI.

Of the Appearance of New ISLANDS, and TRACTS; and of the disappearing of others.

**H**ITHERTO we have taken a survey only of the evils which are produced by subterranean fires, but we have mentioned nothing of the benefits they may possibly produce. They may be of use in warming and cherishing the ground, in promoting vegetation, and giving a more exquisite flavour to the productions of the earth. The imagination of a person who has never been out of our own mild region, can scarcely reach to that luxuriant beauty with which all Nature appears clothed in those very countries that we have but just now described as desolated by earthquakes, and undermined by subterranean fires. It must be granted, therefore, that though in those regions they have a greater share in the dangers, they have also a larger proportion in the benefits of Nature.

But there is another advantage arising from subterranean fires, which, though hitherto disregarded by man, yet may one day become serviceable to him; namely, that while they are found to swallow up cities and plains in one place, they are also known to produce promontories and islands in another. We have many instances of islands being thus formed in the midst of the sea, which though for a long time barren, have afterwards become fruitful seats of happiness and industry.

New islands are formed in two ways; either suddenly, by the action of subterraneous fires; or more slowly, by the deposition of mud, carried down by rivers, and stopped by some accident. With respect particularly to the first, ancient historians, and modern travellers, give us such accounts as we can have no room to doubt of. Seneca assures us, that in his time the island of Therasia appeared unexpectedly to some mariners, as they were employed in another pursuit. Pliny assures us, that thirteen islands in the Mediterranean appeared at once emerging from the water; the cause of which he ascribes rather to the retiring of the sea in those parts, than to any subterraneous elevation. However, he mentions the island of Hieria, near that of Therasia, as formed by subterraneous explosions; and adds to his list several others, formed in the same manner. In one of which he relates that fish in great abundance were found, and that all those who eat of them died shortly after.

“On the twenty-fourth of May, in the year 1707, a slight earthquake was perceived at Santorin; and the day following, at sun-rising, an object was seen by the inhabitants of that island, at two or three miles distant at sea, which appeared like a floating rock. Some persons, desirous either of gain or excited by curiosity, went there, and found, even while they stood upon this rock, that it seemed to rise beneath their feet. They perceived also that its surface was covered with pumice stones and oysters, which it had raised from the bottom. Every day after, until the fourteenth of June, this rock seemed considerably to increase; and then was found to be half a mile round, and about thirty feet above the sea. The earth of which it was composed seemed whitish, with a small portion of clay. Soon after this the sea again appeared troubled, and steams arose, which were very offensive to the inhabitants of Santorin. But on the sixteenth of the succeeding month, seventeen or eighteen rocks more were seen to rise out of the sea, and at length to join together. All this was accompanied with the most terrible noise, and fires which proceeded from the island that was newly formed. The whole mass, however, of all this new-formed earth, uniting, increased every day, both in height and breadth, and, by



by the force of its explosions, cast forth rocks to seven miles distance. This continued to bear the same dreadful appearances till the month of November in the same year; and it is at present a volcano which sometimes renews its explosions. It is about three miles in circumference, and more than from thirty-five to forty feet high.

It seems extraordinary, that about this place in particular, islands have appeared at different times, particularly that of Hiera, mention above, which has received considerable additions in succeeding ages. Justin tells us, that at the time the Macedonians were at war with the Romans, a new island appeared between those of Theramenes and Therasia, by means of an earthquake. We are told, that this became half as big again about a thousand years after; another island rising up by its side, and joining to it, so as scarce at present to be distinguished from the former.

A new island was formed, in the year 1720, near that of Terceira, near the continent of Africa, by the same causes. In the beginning of December, at night, there was a terrible earthquake at that place, and the top of a new island appeared, which cast forth smoke in vast quantities. The pilot of a ship, who approached it, sounded on one side of this island, and could not find ground at sixty fathom. At the other side the sea was totally tinged of a different colour, exhibiting a mixture of white, blue, and green; and was very shallow. This island, on its first appearance, was larger than it is at present; for it has, since that time, sunk in such a manner, as to be scarce above water.

A traveller, whom these appearances could not avoid affecting, speaks of them in this manner: "What can be more surprising than to see fire not only break out of the bowels of the earth, but also to make itself a passage through the waters of the sea! What can be more extraordinary or foreign to our common notions of things, than to see the bottom of the sea rise up into a mountain above the water; and become so firm an island as to be able to resist the violence of the greatest storms! I know that subterraneous fires, when pent in a narrow passage, are able to raise up a mass of earth as large as an island. But that this should be done in so regular and exact a manner, that the water of the sea should not be able to penetrate and extinguish those fires; that, after having made so many passages, they should retain force enough to raise the earth; and, in fine, after having been extinguished, that the mass of earth should not fall down, or sink again with its own weight, but still remain in a manner suspended over the great arch below! This is what to me seems more surprising than anything that has been related of Mount Ætna, Vesuvius, or any other volcano."

Such are his sentiments; however, there are few of these appearances any way more extraordinary than those attending volcanoes and earthquakes in general. We are not more to be surprised that inflammable substances should be found beneath the bottom of the sea, than at similar depths at land. These have all the force of fire giving expansion to air, and tending to raise the earth at the bottom of the sea, till it at length heaves above water. These marine volcanoes are not so frequent; for, if we may judge of the usual procedure of Nature, it must very often happen that, before the bottom of the sea is elevated above the surface, a chasm is opened in it, and then the water pressing in, extinguishes the volcano before it has time to produce its effects. This extinction, however, is not effected without very great resistance from the fire beneath. The water, upon dashing into the cavern, is very probably at first ejected back with great violence; and thus some of those amazing water-spouts are seen,

which have so often astonished the mariner, and excited curiosity. — But of these in their place.

Besides the production of those islands by the action of fire, there are others, as was said, produced by rivers or seas carrying mud, earth, and such like substances, along with their currents; and at last depositing them in some particular place. At the mouths of most great rivers, there are to be seen banks, thus formed by the sand and mud carried down with the stream, which have rested at that place, where the force of the current is diminished by its junction with the sea. These banks, by slow degrees, increase at the bottom of the deep; the water in those places, is at first found by mariners to grow more shallow; the bank soon heaves up above the surface; it is considered, for a while, as a tract of useless and barren sand; but the seeds of some of the more hardy vegetables are driven thither by the wind, take root, and thus binding the sandy surface, the whole spot is clothed in time with a beautiful verdure. In this manner there are delightful and inhabited islands at the mouths of many rivers, particularly the Nile, the Po, the Mississippi, the Ganges, and the Senegal. There has been, in the memory of man, a beautiful and large island formed in this manner, at the mouth of the river Nanquin, in China, made from depositions of mud at its opening: it is not less than sixty miles long, and about twenty broad. La Loubere informs us, in his voyage to Siam, that these sand-banks increase every day, at the mouths of all the great rivers in Asia; and hence he asserts, that the navigation up these rivers becomes every day more difficult; and will, at one time or another, be totally obstructed. The same may be remarked with regard to the Wolga, which has at present seventy openings into the Caspian sea; and of the Danube, which has seven into the Euxine. We have had an instance of the formation of a new island, not very long since, at the mouth of the Humber, in England. "It is yet within the memory of man," says the relator, "since it began to raise its head above the ocean. It began its appearance at low water, for the space of a few hours; and was buried again till the next tide's retreat. Thus, successively, it lived and died, until the year 1666, when it began to maintain its ground against the insult of the waves; and then first invited the aid of human industry. A bank was thrown about its rising grounds; and being thus defended from the incursions of the sea, it became firm and solid, and, in a short time, afforded good pasturage for cattle. It is about nine miles in circumference, and is worth to the proprietor about eight hundred pounds a year." It would be endless to mention all the islands that have been thus formed, and the advantages that have been derived from them.

However, it is frequently found, that new islands may often be considered as only turning the rivers from their former beds, so that, in proportion as land is gained at one part, it is lost by the overflowing of some other. Little, therefore, is gained by such accretions; nor is there much more by the new islands which are sometimes formed from the spoils of the continent. — Mariners assure us, that there are sometimes whole plains uprooted from the main lands, by floods and tempests. These being carried out to sea, with all their trees and animals upon them, are frequently seen floating in the ocean, and exhibiting a surprising appearance of rural tranquillity in the midst of danger. The greatest part, however, having the earth at their roots at length washed away, are dispersed, and their animals drowned; but now and then some are found to brave the fury of the ocean, till being stuck either among rocks or sands, they again take firm footing, and become permanent islands.



As different causes have thus concurred to produce new islands, so we have accounts of others that the same causes have contributed to destroy. We have already seen the power of earthquakes exerted in sinking whole cities, and leaving lakes in their room. There have been islands, and regions also, that have shared the same fate; and have sunk with their inhabitants, never more to be heard of. Thus Pausanias tells us of an island, called Chryses, that was sunk near Lemnos. Pliny mentions several; among others, the island of Cea, for thirty miles, having been washed away, with several thousands of its inhabitants. But of all the noted devastations of this kind, the total submersion of the island of Atalantis, as mentioned by Plato, has been most the subject of speculation. Mankind, in general, now consider the whole of his account as an ingenious fable; but when fables are grown famous by time and authority, they become an agreeable, if not a necessary part of literary information.

"About nine thousand years are passed," says Plato, "since the island of Atalantis was in being. The priests of Egypt were well acquainted with it; and the first heroes of Athens gained much glory in their wars with the inhabitants. This island was as large as Asia Minor and Syria united; and was situated beyond the pillars of Hercules, in the Atlantic ocean. The beauty of the buildings, and the fertility of the soil, were far beyond any thing a modern imagination can conceive; gold and ivory were every where common; and the fruits of the earth offered themselves without cultivation. The arts, and the courage of the inhabitants, were not inferior to the happiness of their situation; and they were frequently known to make conquests, and over-run the continent of Europe and Asia. The imagination of the poetical philosopher riots in the description of the natural and acquired advantages, which they long enjoyed in this charming region. If, says he, we compare that country to our own, ours will appear a mere wasted skeleton, when opposed to it. Their mountains to the very tops were clothed with fertility, and poured down rivers to enrich the plains below."

However, all these beauties and benefits were destroyed in one day by an earthquake sinking the earth, and the sea overwhelming it. At present, not the smallest vestiges of such an island are to be found; Plato remains as the only authority for its existence; and philosophers dispute about its situation. However, we do not mean to enter into the controversy, as there appears but little probability to support the fact; and, indeed, it would be useless to run back nine thousand years in search of difficulties, as we are surrounded with objects that more closely affect us, and that demand admiration at our very doors. When we consider, as Lactantius suggests, the various vicissitudes of nature; lands swallowed by yawning earthquake, or overwhelmed in the deep; rivers and lakes disappearing, or dried away; mountains levelled into plains; and plains swelling up into mountains; we cannot help regarding this earth as a place of very little stability: as a transient abode of still more transitory beings.

## CHAP. XII.

### OF MOUNTAINS.

**H**AVING at last, in some measure, emerged from the depths of the earth, we come to a scene of greater splendour; the contemplation of its external appearance. In this survey, its mountains are the first objects that strike the imagination, and excite our curiosity. There is not, perhaps, any thing in all nature that impresses an unaccustomed

spectator with such ideas of awful solemnity, as these immense piles of Nature's erecting, that seem to mock the minuteness of human magnificence.

In countries where there are nothing but plains, the smallest elevations are apt to excite wonder. In Holland, which is all a flat, they shew a little ridge of hills, near the sea-side, which Boerhaave generally marked out to his pupils, as being mountains of no small consideration. What would be the sensations of such an auditory, could they at once be presented with a view of the heights and precipices of the Alps, or the Andes! Even among us, in England, we have no adequate ideas of a mountain-prospect; our hills are generally sloping from the plain, and clothed to the very top with verdure; we can scarce, therefore, lift our imaginations to those immense piles whose tops peep up behind intervening clouds, sharp and precipitate, and reach to heights that human avarice or curiosity have never been able to ascend.

We, in this part of the world, are not, for that reason, so immediately interested in the question which has so long been agitated among philosophers, concerning what gave rise to these inequalities on the surface of the globe. In our own happy region, we generally see no inequalities but such as contribute to use and beauty; and we, therefore, are amazed at a question enquiring how such necessary inequalities came to be formed, and seeming to express a wonder how the globe comes to be so beautiful as we find it. But though with us there may be no great cause for such a demand, yet in those places where mountains deform the face of Nature, where they pour down cataracts, or give fury to tempests, there seems to be good reason for enquiry either into their causes or their uses. It has been, therefore, asked by many, in what manner mountains have come to be formed; or for what uses they are designed?

To satisfy curiosity in these respects, much reasoning has been employed, and very little knowledge propagated. With regard to the first part of the demand, the manner in which mountains were formed, we have already seen the conjectures of different philosophers on that head. One supposing that they were formed from the earth's broken shell, at the time of the deluge: another, that they existed from the creation, and only acquired their deformities in process of time: a third, that they owed their original to earthquakes: and still a fourth, with much more plausibility than the rest, ascribing them entirely to the fluctuations of the deep, which he supposes in the beginning to have covered the whole earth. Such as are pleased with disquisitions of this kind, may consult Burnet, Whiston, Woodward, or Buffon. Nor would we be thought to decry any mental amusements, that at worst keep us innocently employed; but we cannot help wondering how the opposite demand has never come to be made; and why philosophers have never asked how we come to have plains? Plains are sometimes more prejudicial to man than mountains. Upon plains, an inundation has greater power; the beams of the sun are often collected there with suffocating fierceness; they are sometimes found desert for several hundred miles together, as in the country east of the Caspian sea, although otherwise fruitful, merely because there are no risings nor depressions to form reservoirs, or collect the smallest rivulet of water. The most rational answer, therefore, why either mountains or plains were formed, seems to be, that they were thus fashioned by the hand of Wisdom, in order that pain and pleasure should be so contiguous, as that morality might be exercised either in bearing the one, or communicating the other.

Indeed, the more we consider this dispute respecting



specting the formation of mountains, the more we are struck with the futility of the question. There is neither a straight line, nor an exact superficies, in all nature. If we consider a circle, even with mathematical precision, we shall find it formed of a number of small right lines, joining at angles together. These angles, therefore, may be considered in a circle as mountains are upon our globe; and to demand the reason for the one being mountainous, or the other angular, is only to ask why a circle is a circle, or a globe is a globe. In short, if there be no surface without inequality in Nature, why should we be surprised that the earth has such? It has often been said, that the inequalities of its surface are scarce distinguishable, if compared to its magnitude; and indeed we have every reason to be content with the answer.

Some, however, have avoided the difficulty by urging the final cause. They alledge that mountains have been formed merely because they are useful to man. This carries the enquirer but a part of the way; for no one can affirm that in all places they are useful. The contrary is known, by horrid experience, in those valleys that are subject to their influence. However, as the utility of any part of our earthly habitation, is a very pleasing and flattering speculation to every philosopher, it is not to be wondered that much has been said to prove the usefulness of these. For this purpose, many conjectures have been made that have received a degree of assent even beyond their evidence; for men were unwilling to become more miserably wise.

It has been alledged, as one principal advantage that we derive from them, that they serve, like hoops or ribs, to strengthen our earth, and to bind it together. In consequence of this theory, Kircher has given us a map of the earth, in this manner hooped with its mountains; which might have a much more solid foundation, did it entirely correspond with truth.

Others have found a different use for them, especially when they run surrounding our globe; which is, that they stop the vapours which are continually travelling from the equator to the poles; for these being urged by the heat of the sun, from the warm regions of the line, must all be accumulated at the poles, if they were not stopped in their way by those high ridges of mountains which cross their direction. But an answer to this may be, that all the great mountains in America lie lengthwise, and therefore do not cross their direction.

But to leave these remote advantages, others assert, that not only the animal but vegetable part of the creation would perish for want of convenient humidity, were it not for their friendly assistance. Their summits are, by these, supposed to arrest, as it were, the vapours which float in the regions of the air. The large inflexions, and channels, are considered as so many basins prepared for the reception of those thick vapours, and impetuous rains, which descend into them. The huge caverns beneath are so many magazines or conservatories of water for the peculiar service of man: and those orifices by which the water is discharged upon the plain, are so situated as to enrich and render them fruitful, instead of returning through subterraneous channels to the sea, after the performance of a tedious and fruitless circulation.

However this be, certain it is that almost all our great rivers find their source among mountains; and, in general, the more extensive the mountain, the greater the river: thus the river Amazons, the greatest in the world, has its source among the Andes, which are the highest mountains on the globe; the river Niger travels a long course of several hundred miles from the mountains of the Moon, the highest in all Africa; and the Danube

and the Rhine proceed from the Alps, which are probably the highest mountains of Europe.

It need scarce be said that, with respect to height, there are many sizes of mountains, from the gently rising upland, to the tall craggy precipice. The appearance is in general different in those of different magnitudes. The first are clothed with verdure to the very tops, and only seem to ascend to improve our prospects, or supply us with a purer air: but the lofty mountains of the other class have a very different aspect. At a distance their tops are seen, in wavy ridges, of the very colour of the clouds, and only to be distinguished from them by their figure, which, as we have said, resemble the billows of the sea. As we approach, the mountain assumes a deeper colour; it gathers upon the sky, and seems to hide half the horizon behind it. Its summits also are become more distinct, and appear with a broken and perpendicular line. What at first seemed a single hill, is now found to be a chain of continued mountains, whose tops running along in ridges, are embosomed in each other: so that the curvatures of one are fitted to the prominences of the opposite side, and form a winding valley between, often of several miles in extent; and all the way continuing nearly of the same breadth.

Nothing can be finer, or more exact, than Mr. Pope's description of a traveller straining up the Alps. Every mountain he comes to, he thinks will be the last; he finds, however, an unexpected hill rise before him; and that being scaled, he finds the highest summit almost at as great a distance as before. Upon quitting the plain, he might have left a green and a fertile soil, and a climate warm and pleasing. As he ascends, the ground assumes a more russet colour; the grass becomes more mossy, and the weather more moderate. Still as he ascends, the weather becomes more cold, and the earth more barren. In this dreary passage, he is often entertained with a little valley of surprising verdure, caused by the reflected heat of the sun collected into a narrow spot on the surrounding heights. But it much more frequently happens that he sees only frightful precipices beneath, and lakes of amazing depths; from whence rivers are formed, and fountains derive their original. On those places next the highest summits, vegetation is scarcely carried on; here and there a few plants of the most hardy kind appear. The air is intolerably cold; either continually refrigerated with frosts, or disturbed with tempests. All the ground here wears an eternal covering of ice, and snows that seem constantly accumulating. Upon emerging from this war of the elements, he ascends into a purer and a serener region, where vegetation is entirely ceased; where the precipices, composed entirely of rocks, rise perpendicularly above him; while he views beneath him all the combat of the elements; clouds at his feet; and thunders darting upward from their bosoms below. A thousand meteors, which are never seen on the plain, present themselves. Circular rainbows; mock suns; the shadow of the mountain projected upon the body of the air; and the traveller's own image, reflected as in a looking-glass, upon the opposite cloud.

Such are, in general, the wonders that present themselves to a traveller in his journey either over the Alps or the Andes. But we must not suppose that this picture exhibits either a constant or an invariable likeness of those stupendous heights. Indeed, nothing can be more capricious or irregular than the forms of many of them. The tops of some run in ridges for a considerable length, without interruption; in others, the line seems indented by great valleys to an amazing depth. Sometimes a solitary and a single mountain rises from the bosom of the plain; and sometimes extensive plains, and even provinces,



provinces, as those of Savoy and Quito, are found embosomed near the tops of mountains. In general, however, those countries that are most mountainous, are the most barren and uninhabitable.

If we compare the heights of mountains with each other, we shall find that the greatest and highest are found under the Line. It is thought by some, that the rapidity of the earth's motion in these parts, together with the greatness of the tides there, may have thrown up those stupendous masses of earth. But, be the cause as it may, it is a remarkable fact, that the inequalities of the earth's surface are greatest there. Near the Poles, the earth, indeed, is craggy and uneven enough; but the heights of the mountains there are very inconsiderable. On the contrary, at the Equator, where Nature seems to sport in the amazing size of all her productions, the plains are extensive; and the mountains remarkably lofty. Some of them are known to rise three miles perpendicular above the bed of the ocean.

To enumerate the most remarkable of these, according to their size, we shall begin with the Andes, of which we have an excellent description by Ulloa, who went thither by command of the king of Spain, in company with the French Academicians, to measure a degree of the meridian. His journey up these mountains is too curious not to give an extract from.

After many incommodious days sailing up the river Guayaquil, he arrived at Caracol, a town situated at the foot of the Andes. Nothing could exceed the inconveniences which he experienced in this voyage, from the flies and moschetoes (an animal resembling our gnat).

"We were the whole day," says he, "in continual motion to keep them off; but at night our torments were excessive. Our gloves, indeed, were some defence to our hands; but our faces were entirely exposed; nor were our cloaths a sufficient defence for the rest of our bodies; for their stings penetrating through the cloth, caused a very painful and fiery itching. One night, in coming to an anchor near a large and handsome house that was uninhabited, we had no sooner seated ourselves in it, than we were attacked on all sides by swarms of moschetoes, so that it was impossible to have one moment's quiet. Those who had covered themselves with cloaths made for this purpose, found not the smallest defence; wherefore, hoping to find some relief in the open fields, they ventured out, though in danger of suffering in a more terrible manner from the serpents. But both places were equally obnoxious. On quitting this inhospitable retreat, we the next night took up our quarters in a house that was inhabited; the host of which being informed of the terrible manner we had passed the night before, he gravely told us, that the house we so greatly complained of, had been forsaken on account of its being the purgatory of a soul. But we had more reason to believe that it was quitted on account of its being the purgatory of the body. After having journeyed for upwards of three days, through boggy roads, in which the mules at every step sunk up to their bellies, we began at length to perceive an alteration in the climate; and having been long accustomed to heat, we now began to feel it grow sensibly colder.

It is remarkable, that at Tariguagua we often see instances of the effects of two opposite temperatures, in two persons happening to meet; one of them leaving the plains below, and the other descending from the mountain. The former thinks the cold so severe, that he wraps himself up in all the garments he can procure; while the latter, finds the heat so great, that he is scarce able to bear any cloaths whatsoever. The one thinks the water so cold, that he avoids being sprinkled by it; the other

is so delighted with its warmth, that he uses it as a bath. Nor is the case very different in the same person, who experiences the same diversity of sensation upon his journey up, and upon his return. This difference only proceeds from the change naturally felt at leaving a climate to which one has been accustomed, and coming into another of an opposite temperature.

"The ruggedness of the road from Tariguagua, leading up the mountain, is not easily described. In some parts, the declivity is so great, that the mules can scarce keep their footing; and in others, the acclivity is equally difficult. The trouble of having people going before to mend the road, the pains arising from the many falls and bruises, and the being constantly wet to the skin, might be supported, were not these inconveniencies augmented by the sight of such frightful precipices, and deep abysses, as must fill the mind with ceaseless terror. There are some places where the road is so steep, and yet so narrow, that the mules are obliged to slide down, without making any use of their feet whatsoever. On one side of the rider, in this situation, rises an eminence of several hundred yards; and on the other, an abyss of equal depth; so that if he in the least checks his mule, so as to destroy the equilibrium, they both must unavoidably perish.

"After having travelled about nine days in this manner, slowly winding along the side of the mountain, we began to find the whole country covered with an hoar frost; and an hut in which we lay had ice on it. Having escaped many perils, we at length, after a journey of fifteen days, arrived upon the plain, on the extremity of which stands the city of Quito, the capital of one of the most charming regions upon earth. Here, in the centre of the torrid zone, the heat is not only very tolerable, but in some places the cold also is painful. Here they enjoy all the temperature and advantages of perpetual spring; their fields being always covered with verdure, and enamelled with flowers of the most lively colours. However, although this beautiful region be higher than any other country in the world, and although it took up so many days of painful journey in the ascent, it is still overlooked by tremendous mountains; their sides covered with snow, and yet flaming with volcanoes at the top. These seemed piled one upon the other, and rise to a most astonishing height, with great coldness. However, at a determined point above the surface of the sea, the congelation is found at the same height in all the mountains. Those parts which are not subject to a continual frost, have here and there growing upon them a rush, resembling the geblu, but much more soft and flexible. Towards the extremity of the part where the rush grows, and the cold begins to increase, is found a vegetable, with a round bulbous head, which, when dried, becomes of amazing elasticity. Higher up the earth is entirely bare of vegetation, and seems covered with eternal snow. The most remarkable mountains are, that of Cotopaxi, (already described as a volcano) Chimborazo, and Pichincha; Cotopaxi is more than three geographical miles above the surface of the sea: the rest are not much inferior. On the top of the latter was my station for measuring a degree of the meridian; where I suffered particular hardships, from the intenseness of the cold, and the violence of the storms. The sky around was, in general, involved in thick fogs, which, when they cleared away, and the clouds, by their gravity, moved nearer to the surface of the earth, they appeared surrounding the foot of the mountain, at a vast distance below, like a sea, encompassing an island in the midst of it. When this happened, the horrid noises of tempests were heard from beneath, then discharging themselves



themselves on Quito, and the neighbouring country. I saw the lightnings issue from the clouds, and heard the thunders roll far beneath me. All this time, while the tempest was raging below, the mountain-top, where I was placed, enjoyed a delightful serenity; the wind was abated; the sky clear; and the enlivening rays of the sun moderated the severity of the cold. However, this was of no very long duration, for the wind returned with all its violence, and with such velocity as to dazzle the sight; whilst my fears were increased by the dreadful concussions of the precipice, and the fall of enormous rocks; the only sounds that were heard in this frightful situation."

Such is the animated picture of these mountains, as given us by this ingenious Spaniard. A passage over the Alps, or a journey across the Pyrenées, appear petty trips or excursions, in the comparison; and yet these are the most lofty mountains we know of in Europe.

If we compare the Alps with the mountains already described, we shall find them but little more than one half of the height of the former. The Andes, upon being measured by the barometer, are found above three thousand one hundred and thirty-six toises or fathoms above the surface of the sea. Whereas the highest point of the Alps is not above sixteen hundred. The one, in other words, is above three miles high; the other, about a mile and a half. The highest mountains in Asia are, Mount Taurus, Mount Immaus, Mount Caucasus, and the mountains of Japan.—Of these, none equals the Andes in height; although Mount Caucasus, which is the highest of them, makes very near approaches. Father Verbiest tells of a mountain in China, which he measured, and found a mile and a half high. In Africa, the mountains of the Moon, famous for giving source to the Niger, and the Nile, are rather more noted than known. Of the Pike of Teneriffe, one of the Canary Islands that lie off this coast, we have more certain information. In the year 1727, it was visited by a company of English merchants, who travelled up to the top, where they observed its height, and the volcano on its very summit. They found it an heap of mountains, the highest of which rises over the rest like a sugar-loaf, and gives a name to the whole mass. It is computed to be a mile and a half perpendicular from the surface of the sea. Kircher gives us an estimate of the heights of most of the other great mountains in the world; but as he has taken his calculations, in general, from the ancients, or from modern travellers, who had not the art of measuring them, they are quite incredible. The art of taking the heights of places by the barometer, is a new, and an ingenious invention. As the air grows lighter as we ascend, the fluid in the tube rises in due proportion; thus the instrument being properly marked, gives the height with a tolerable degree of exactness; at least enough to satisfy curiosity.

Few of our great mountains have been estimated in this manner; travellers having, perhaps, been deterred, by a supposed impossibility of breathing at the top. However, it has been invariably found, that the air in the highest that our modern travellers have ascended, is not at all too fine for respiration. At the top of the Pike of Teneriffe, there was found no other inconvenience from the air, except its coldness; at the top of the Andes there was no difficulty of breathing perceived. The accounts, therefore, of those who have asserted that they were unable to breathe, although at much less heights, are greatly to be suspected. In fact, it is very natural for mankind to paint those obstacles as insurmountable, which they themselves have not had the fortitude or perseverance to surmount.

The difficulty and danger of ascending to the tops

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of mountains, proceeds from other causes, not the thinness of the air. For instance, some of the summits of the Alps have never yet been visited by man; but the reason is, that they rise with such a rugged and precipitate ascent, that they are utterly inaccessible. In some places they appear like a great wall of six or seven hundred feet high; in others, there stick out enormous rocks, that hang upon the brow of the steep, and every moment threaten destruction to the traveller below.

In this manner almost all the tops of the highest mountains are bare and pointed. And this naturally proceeds from their being so continually assaulted by thunders and tempests. All the earthy substances with which they might have been once covered, have for ages been washed away from their summits; and nothing is left remaining, but immense rocks, which no tempest has hitherto been able to destroy.

Nevertheless, time is every day, and every hour, making depredations; and huge fragments are seen tumbling down the precipice, either loosed from the summit by frost or rains, or struck down by lightning. Nothing can exhibit a more terrible picture than one of these enormous rocks, commonly larger than an house, falling from its height, with a noise louder than thunder, and rolling down the side of the mountain. Doctor Plot tells us of one in particular, which being loosened from its bed, tumbled down the precipice, and was partly shattered into a thousand pieces. Notwithstanding, one of the largest fragments of the same, still preserving its motion, travelled over the plain below, crossed a rivulet in the midst, and at last stopped on the other side of the bank! These fragments, as was said, are often struck off by lightning, and sometimes undermined by rains; but the most usual manner in which they are disunited from the mountain, is by frost: the rains insinuating between the interstices of the mountain, continue there until there comes a frost, and then, when converted into ice, the water swells with an irresistible force, and produces the same effect as gun-powder, splitting the most solid rocks, and thus shattering the summits of the mountain.

But not rocks alone, but whole mountains are, by various causes, disunited from each other. We see, in many parts of the Alps, amazing clefts, the sides of which so exactly correspond with the opposite, that no doubt can be made of their having been once joined together. At Cajeta, in Italy, a mountain was split in this manner by an earthquake; and there is a passage opened through it, that appears as if elaborately done by the industry of man. In the Andes these breaches are frequently seen. That at Thermopylae, in Greece, has been long famous. The mountain of the Troglodytes, in Arabia, has thus a passage through it: and that in Savoy, which Nature began, and which Victor Amadeus completed, is an instance of the same kind.

We have accounts of some of these disruptions, immediately after their happening. In the month of June, in the year 1714, a part of the mountain of Diableret, in the district of Valais, in France, suddenly fell down, between two and three o'clock in the afternoon, the weather being very calm and serene. It was of a conical figure, and destroyed fifty-five cottages in the fall. Fifteen persons, together with about an hundred beasts, were also crushed beneath its ruins, which covered an extent of a good league square. The dust it occasioned, instantly covered all the neighbourhood in darkness. The heaps of rubbish were more than three hundred feet high. They stopped the current of a river that ran along the plain, which is now formed into several new and deep lakes. There appeared, through the whole of this rubbish, none of those substances



substances that seemed to indicate that this disruption had been made by means of subterraneous fires. Most probably, the base of this rocky mountain was rotted and decayed; and thus fell without any extraneous violence. In the same manner, in the year 1618, the town of Pleurs, in France, was buried beneath a rocky mountain, at the foot of which it was situated.

These accidents, and many more that might be enumerated of the same kind, have been produced by various causes: by earthquakes, as in the mountain at Cajota; or by being decayed at the bottom, as at Diableret. But the most general way is, by the foundation of one part of the mountain being hollowed by waters, and, thus wanting a support, breaking from the other. Thus it generally has been found in the great chafms in the Alps; and thus it almost always is known in those disruptions of hills, which are known by the name of land-slips. These are nothing more than the slidings down of an higher piece of ground, disrooted from its situation by subterraneous inundations, and settling itself upon the plain below.

There is not an appearance in all nature that so much astonished our ancestors, as these land-slips. In fact, to behold a large upland, with its houses, its corn, and cattle, at once loosened from its place, and floating, as it water, upon the subjacent water; to behold it quitting its ancient situation, and travelling forward like a ship, in quest of new adventures; this is certainly one of the most extraordinary appearances that can be imagined; and to a people, ignorant of the powers of Nature, might well be considered as a prodigy. Accordingly, we find all our old historians mentioning it as an omen of approaching calamities. In this more enlightened age, however, its cause is very well known; and, instead of exciting ominous apprehensions in the populace, it only gives rise to some very ridiculous law-suits among them, about whose the property shall be; whether the land which has thus slipped, shall belong to the original possessor, or to him upon whose grounds it has encroached and settled. What has been the determination of the judges, is not so well known; but the circumstances of the slips have been minutely and exactly described.

In the lands of Starberg, in the kingdom of Iceland, there stood a declivity, gradually ascending for near half a mile. In the year 1713, and on the 10th of March, the inhabitants perceived a crack on its side, somewhat like a furrow made with a plough, which they imputed to the effects of lightning, as there had been thunder the night before. However, on the evening of the same day, they were surprised to hear an hideous confused noise issuing all round from the side of the hill; and their curiosity being raised, they resorted to the place. There, to their amazement, they found the earth, for near five acres, all in gentle motion, and sliding down the hill upon the subjacent plain. This motion continued the remaining part of the day, and the whole night; nor did the noise cease during the whole time; proceeding, probably, from the attrition of the ground beneath. The day following, however, this strange journey down the hill ceased entirely; and above an acre of the meadow below was found covered with what before composed a part of the declivity.

However, these slips, when a whole mountain's side seems to descend, happen but very rarely. There are some of another kind, however, much more common; and, as they are always sudden, much more dangerous. These are snow-slips, well known, and greatly dreaded by travellers. It often happens, that when snow has long been accumulated on the tops and on the sides of mountains, it is born down the precipice, either by means of tem-

pests, or its own melting. At first, when loosened, the volume in motion is but small, but gathers as it continues to roll; and, by the time it has reached the habitable parts of the mountain, is generally grown of enormous bulk. Wherever it rolls it levels all things in its way, or buries them in unavoidable destruction. Instead of rolling, it sometimes is found to slide along from the top; yet even thus it is generally as fatal as before. Nevertheless, we have had an instance, a few years ago, of a small family in Germany, that lived for above a fortnight beneath one of these snow-slips. Although they were buried, during that whole time, in utter darkness, and under a bed of some hundred feet deep, yet they were luckily taken out alive; the weight of the snow being supported by a beam that kept up the roof; and nourishment being supplied them by the milk of an ass, that was buried under the same ruin.

But it is not the parts, alone, that are thus found to subside, whole mountains have been known totally to disappear. Pliny tells us, that in his own time, the lofty mountain of Cybotus, together with the city of Eurites, were swallowed by an earthquake. The same fate, he says, attended Phlegium, one of the highest mountains in Æthiopia; which, after one night's concussion, was never seen more. In more modern times, a very noted mountain in the Molucca islands, known by the name of the Peak, and remarkable for being seen at a very great distance from sea was swallowed by an earthquake; and nothing but a lake was left in the place where it stood. Thus, while storms and tempests are levelled against mountains above, earthquakes and waters are undermining them below. All our histories talk of their destruction; and very few new ones (if we except Mount Cenere, and one or two such heaps of cinders) are produced. If mountains, therefore, were of such great utility as some philosophers make them to mankind, it would be a very melancholy consideration that such benefits were diminished every day. But the truth is, the valleys are fertilized by that earth which is washed from their sides; and the plains become richer, in proportion as the mountains decay.

## C H A P. XIII.

### O f W A T E R.

**I**N contemplating nature, we shall often find the same substances possessed of contrary qualities, and producing opposite effects. Air, which liquifies one substance, dries up another. That fire which is seen to burn up the desert, is often found, in other places, to assist the luxuriance of vegetation; and water, which, next to fire, is the most fluid substance upon earth, nevertheless, gives all other bodies their firmness and durability; so that every element seems to be a powerful servant, capable either of good or ill, and only awaiting external direction, to become the friend or the enemy of mankind. These opposite qualities, in this substance in particular, have not failed to excite the admiration and enquiry of the curious.

That water is the most fluid, penetrating body, next to fire, and the most difficult to confine, is incontestibly proved by a variety of experiments. A vessel through which water cannot pass, may be said to retain anything. It may be objected, indeed, that syrups, oils, and honey, leak through some vessels that water cannot pass through; but this is far from being the result of the greater tenuity and fineness of their parts; it is owing to the resin wherewith the wood of such vessels abounds, which oils and syrups have a power of dissolving; so that these fluids, instead of finding their way, may more properly



properly be said to eat their way through the vessels that contain them. However, water will at last find its way even through these; for it is known to escape through vessels of every substance, glass only excepted. Other bodies may be found to make their way out more readily indeed; as air, when it finds a vent, will escape at once; and quicksilver, because of its weight, quickly penetrates through whatever chinky vessel confines it: but water, though it operates more slowly, yet always finds a more certain issue. As, for instance, it is well known that air will not pass through leather; which water will very readily penetrate. Air also may be retained in a bladder; but water will quickly ooze through. And those who drive this to the greatest degree of precision, pretend to say, that it will pass through pores ten times smaller than air can do. Be this as it may, we are very certain that its parts are so small that they have been actually driven through the pores of gold. This has been proved by the famous Florentine experiment, in which a quantity of water was shut up in an hollow ball of gold, and then pressed with an huge force by screws, during which the fluid was seen to ooze through the pores of the metal, and to stand, like a dew, upon its surface.

As water is thus penetrating, and its parts thus minute, it may easily be supposed that they enter into the composition of all bodies, vegetable, animal, and fossil. This every chemist's experience convinces him of; and the mixture is the more obvious, as it can always be separated, by a gentle heat, from those substances with which it had been united. Fire, as was said, will penetrate where water cannot pass; but then it is not so easily to be separated. But there is scarce any substance from which its water cannot be divorced. The parings or filings of lead, tin, and antimony, by distillation, yield water plentifully: the hardest stones, sea-salt, nitre, vitriol, and sulphur, are found to consist chiefly of water; into which they resolve by force of fire. "All birds, beasts, and fishes," says Newton, "insects, trees, and vegetables, with their parts grow from water; and, by putrefaction, return to water again." In short, almost every substance that we see, owes its texture and firmness to the parts of water that mix with its earth; and, deprived of this fluid, becomes a mass of shapeless dust and ashes.

From hence we see, as was above hinted, that this most fluid body, when mixed with others, gives them consistence and form. Water, by being mixed with earth or ashes, and formed into a vessel; when baked before the fire, becomes a copel, remarkable for this, that it will bear the utmost force of the hottest furnace that art can contrive. So the Chinese earth, of which porcelane is made, is nothing more than an artificial composition of earth and water united by heat; and which a greater degree of heat could easily separate. Thus we see a body, extremely fluid of itself; in some measure assuming a new nature, by being united with others; we see a body, whose fluid and dissolving qualities are so obvious, giving consistence and hardness to all the substances of the earth.

From considerations of this kind, Thales, and many of the ancient philosophers, held that all things were made of water. In order to confirm this opinion, Helmont made an experiment, by divesting a quantity of earth of all its oils and salts, and then putting this earth, so prepared, into an earthen pot, which nothing but rain-water could enter, and planting a willow therein; this vegetable, so planted, grew up to a considerable height and bulk, merely from the accidental aspersions of rain-water; while the earth in which it was planted received no sensible diminution. From this experiment, he concluded, that water was the only nourishment of the

vegetable tribe; and that vegetables, being the nourishment of animals, all organized substances, therefore, owed their support and being only to water. But this has been said by Woodward to be a mistake: for he shews, that water being impregnated with earthy particles, is only the conveyer of such substances into the pores of vegetables, rather than an increaser of them, by its own bulk: and likewise, that water is ever found to afford so much less nourishment, in proportion as it is purified by distillation. A plant in distilled water will not grow so fast as in water not distilled: and if the same be distilled three or four times over, the plant will scarce grow at all, or receive any nourishment from it. So that water, as such, does not seem the proper nourishment of vegetables, but only the vehicle thereof, which contains the nutritious particles, and carries them through all parts of the plants. Water, in its pure state, may suffice to extend or swell the parts of a plant, but affords vegetable matter in a moderate proportion.

However this be, it is agreed on all sides, that water, such as we find it, is far from being a pure simple substance. The most genuine, we know, is mixed with exhalations and dissolutions of various kinds; and no expedient that has been hitherto discovered, is capable of purifying it entirely. If we filter and distil it a thousand times, according to Boerhaave, it will still depose a sediment: and by repeating the process, we may evaporate it entirely away, but can never totally remove its impurities. Some, however, assert, that water, properly distilled will have no sediment; and that the little white speck which is found at the bottom of the still, is a substance that enters from without. Kircher used to shew, in his Museum, a phial of water, that had been kept for fifty years, hermetically sealed; during which time it deposed no sediment, but continued as transparent as when first it was put in. How far, therefore, it may be brought to a state of purity by distillation, is unknown; but we very well know, that all such water as we every where see, is a bed in which plants, minerals, and animals, are all found confusedly floating together.

Rain-water, which is a fluid of Nature's own distilling, and which has been raised so high by evaporation, is, nevertheless, a very mixed and impure substance. Exhalations of all kinds, whether salts, sulphurs, or metals, make a part of its substance, and tend to increase its weight. If we gather the water that falls, after a thunder clap, in a sultry summer's day, and let it settle, we shall find a real salt sticking at the bottom. In winter, however, its impure mixtures are fewer, but still may be separated by distillation. As to that which is generally caught pouring from the tops of houses, it is particularly foul, being impregnated with the smoke of the chimnies, the vapour of the slates or tiles, and with other impurities that birds and animals may have deposited there. Besides, though it should be supposed free from all these, it is mixed with a quantity of air, which, after being kept for some time, will be seen to separate.

Spring-water is next in point of purity. This, according to Dr. Halley, is collected from the air itself; which being sated with water, and coming to be condensed by the evening's cold, is driven against the tops of the mountains, where being condensed, and collected, it trickles down by the sides, into the cavities of the earth; and running for a while under-ground, bubbles up in fountains upon the plain. This having made but a short circulation, has generally had no long time to dissolve or imbibe any foreign substances by the way.

River-water is generally more foul than the former. Wherever the stream flows, it receives a tincture from its channel. Plants, minerals, and animals,



mals, all contribute to add to its impurities: so that such as live at the mouths of great rivers, are generally subject to all those disorders which contaminated and unwholesome waters are known to produce. Of all the river-water in the world, that of the Indus and the Thames, are said to be most light and wholesome.

The most impure fresh water that we know, is that of stagnating pools and lakes, which, in summer, may be more properly considered as a jelly of floating insects, than a collection of water. In this, millions of little reptiles, undisturbed by any current, which might crush their frames to pieces, breed and engender. The whole teems with shapeless life, and only grows more fruitful by increasing putrefaction.

Of the purity of all these waters, the lightness, and not the transparency, ought to be the test. Water may be extremely clear and beautiful to the eye, and yet very much impregnated with mineral particles. In fact, sea-water is the most transparent of any, and yet is well known to contain a large mixture of salt and bitumen. On the contrary, those waters which are lightest, have the fewest dissolutions floating in them; and may, therefore, be the most useful for all the purposes of life. But, after all, though much has been said upon this subject; and although waters have been weighed with great assiduity, to determine their degree of salubrity; yet neither this, nor their curdling with soap, nor any other philosophical standard whatsoever, will answer the purposes of true information. Experience alone ought to determine the useful, or noxious qualities, of every spring; and experience assures us, that different kinds of water are adapted to different constitutions. An incontestible proof of this, are the many medicinal springs throughout the world, whose peculiar benefits are known to the natives of their respective countries. These are of various kinds, according to the different minerals with which they are impregnated; hot, saline, sulphureous, bituminous, and oily. But the account of these have been already given under that of the several minerals by which they are produced.

After all therefore, we must be contented with an impure mixture for our daily beverage: and yet, perhaps, this very mixture may often be more serviceable to our health than that of a purer kind. We know that it is so with regard to vegetables: and why not, also, in general, to man? Be this as it will, if we are desirous of having water in its greatest purity, we are ordered, by the curious in this particular, to distil it from snow, gathered upon the tops of the highest mountains, and to take none but the outer and superficial part thereof. This we must be satisfied to call pure water; but even this is far short of the pure unmixed philosophical element; which, in reality, is no where to be found.

As water is thus mixed with foreign matter, and often the repository of minute animals, or vegetable seeds, we need not be surprised that, when carried to sea, it is always found to putrefy. But we must not suppose that it is the element itself, which thus grows putrid, and offensive, but the substances with which it is impregnated. It is true, the utmost precautions are taken to destroy all vegetable and animal substances that may have previously been lodged in it, by boiling: but, notwithstanding this, there are some that will still survive the operation; and others, that find their way during the time of its stowage. Seamen, therefore, assure us, that their water is generally found to putrefy twice, at least, and sometimes three times, in a long voyage. In about a month after it has been at sea, when the bung is taken out of the cask, it sends up a noisome

and dangerous vapour, which would take fire upon the application of a candle. The whole body of the water then is found replete with little worm-like insects, that float, with great briskness, through all its parts. These generally live for about a couple of days, and then dying, by depositing their spoils, for a while increase the putrefaction. After a time, the heavier parts of these sinking to the bottom, the lighter float, in a scum, at the top; and this is what the mariners call, the water's purging itself. There are still, however, another race of insects, which are bred, very probably, from the spoils of the former; and produce, after some time, similar appearances: these dying, the water is then thought to change no more. However, it very often happens, especially in hot climates, that nothing can drive these noisome insects from the ship's store of water. They often increase to a very disagreeable and frightful size, so as to deter the mariner, though parching with thirst, from tasting that cup which they have contaminated.

This water, as thus described, therefore, is a very different fluid from that simple elementary substance upon which philosophical theories have been founded; and concerning the nature of which there have been so many disputes. Elementary water is no way compounded; but is without taste, smell, or colour; and incapable of being discerned by any of the senses, except the touch. This is the famous dissolvent of the chemists, into which, as they have boasted, they can reduce all bodies; and which makes up all other substances, only by putting on a different disguise. In some forms, it is fluid, transparent, and evasive of the touch; in others, hard, firm, and elastic. In some, it is stiffened by cold; in others, dissolved by fire. According to them, it only assumes external shapes from accidental causes; but the mountain is as much a body of water as the cake of ice that melts on its brow; and even the philosopher himself is composed of the same materials with the cloud or meteor which he contemplates.

Speculation seldom rests when it begins. Others, disallowing the universality of this substance, will not allow that in a state of nature there is any such thing as water at all. What assumes the appearance, say they, is nothing more than melted ice. Ice is the real element of Nature's making; and when found in a state of fluidity, it is then in a state of violence. All substances are naturally hard; but some more readily melt with heat than others. It requires a great heat to melt iron; a smaller heat will melt copper: silver, gold, tin, and lead, melt with smaller still; ice, which is a body like the rest, melts with a very moderate warmth; and quicksilver melts with the smallest warmth of all. Water, therefore, is but ice kept in continual fusion; and still returning to its former state, when the heat is taken away. Between these opposite opinions, the controversy has been carried on with great ardour; much has been written on both sides; and yet, when we come to examine the debate, it will probably terminate in this question, whether cold or heat first began their operations upon water? This is a fact of very little importance, if known; and what is more, it is a fact we can never know.

Indeed, if we examine into the operations of cold and heat on water, we shall find that they produce somewhat similar effects. Water dilates in its bulk, by heat, to a very considerable degree; and, what is more extraordinary, it is likewise dilated by cold in the same manner.

If water be placed over a fire, it grows gradually larger in bulk, as it becomes hot, until it begins to boil; after which, no art can either increase its bulk, or its heat. By increasing the fire, indeed, it may be more quickly evaporated away; but its heat



and its bulk, still continue the same. By the expanding of this fluid by heat, philosophers have found a way to determine the warmth or the coldness of other bodies: for if put into a glass tube, by its swelling and rising, it shews the quantity of heat in the body to which it is applied; and by its contracting, and sinking, it shews the absence of the same. Instead of using water in this instrument, which is called a thermometer, they now make use of spirit of wine, which is not apt to freeze, and which is endued even with a greater expansion, by heat, than water. The instrument consists of nothing more than a hollow ball of glass, with a long tube growing out of it. This being partly filled with spirits of wine, tinged red, so as to be seen when it rises, the ball is plunged into boiling water, which making the spirit within expand and rise in the tube, the water marks the greatest height to which it ascends; at this point the tube is to be broken off, and then hermetically sealed, by melting the glass with a blow-pipe: a scale being placed by the side, completes the thermometer. Now as the fluid expands or condenses with heat or cold, it will rise and fall in the tube in proportion; and the degree or quantity of ascent or descent will be seen in the scale.

No fire, as was said, can make water hotter, after it begins to boil. We can, therefore, at any time be sure of an equable certain heat; which is that of boiling water, which is invariably the same. The certainty of such an heat is not less useful than the instrument that measures it. It affords a standard, fixed, degree of heat over the whole world; boiling water being as hot in Greenland, as upon the coasts of Guinea. One fire is more intense than another: of heat there are various degrees; but boiling water is an heat every where the same, and easily procurable.

As heat thus expands water; so cold, when it is violent enough to freeze the same, produces exactly the same effect, and expands it likewise. Thus water is acted upon in the same manner by two opposite qualities; being dilated by both. As a proof that it is dilated by cold, we have only to observe the ice floating on the surface of a pond, which it would not do were it not dilated, and grown more bulky, by freezing, than the water, which remains unfrozen. Mr. Boyle, however, put the matter past a doubt, by a variety of experiments. Having poured a proper quantity of water into a strong earthen vessel, he exposed it, uncovered, to the open air, in frosty nights; and observed, that continually the ice reached higher than the water, before it was frozen. He filled also a tube with water, and stopped both ends with wax: the water, when froze, was found to push out the stopples from both ends; and a rod of ice appeared at each end of the tube, which shewed how much it was swollen by the cold within.

From hence, therefore, we may be very certain of the cold's dilating of the water; and experience also shews, that the force of this expansion has been found as great as any which heat has been found to produce. The touch-hole of a strong gun barrel being stopped, and a plug of iron forcibly driven into the muzzle, after the barrel had been filled with water, it was placed in a mixture of ice and salt: the plug, though soldered to the barrel, at first gave way, but being fixed in more firmly, within a quarter of an hour the gun barrel burst with a loud noise, and blew up the cover of the box wherein it lay. Such is its force in an ordinary experiment. But it has been known to burst cannons, filled with water, and then left to freeze; for the cold congealing the water, and the ice swelling, it became irresistible. The bursting of rocks, by frost, which is frequent in the Northern climates, and is sometimes seen in our own, is an equal proof of the expansion of con-

gealed water; for having, by some means, insinuated itself into the body of the rock, it has remained there till the cold was sufficient to affect it by congelation. But when once frozen, no obstacle is able to confine it from dilating; and, if it cannot otherwise find room, the rock must burst asunder.

This alteration in the bulk of water, might have served as a proof that it was capable of being compressed into a narrower space than it occupied before; but, till of late, water was held to be incompressible. The general opinion was, that no art whatsoever could squeeze it into a narrower compass; that no power on earth, for instance, could force a pint of water into a vessel that held an hair's breadth less than a pint. And this, said they, appears from the famous Florentine experiment; where the water, rather than suffer compressure, was seen to ooze through the pores of the solid metal; and, at length, making a cleft in the side, spun out with great vehemence. But later trials have proved that water is very compressible, and partakes of that elasticity which every other body possesses in some degree. Indeed, had not mankind been dazzled by the brilliancy of one inconclusive experiment, there were numerous reasons to convince them of its having the same properties with other substances. Ice, which is water in another state, is very elastic. A stone flung slantingly along the surface of a pond, bounds from the water several times, which shews it to be elastic also. But the trials of Mr. Canton have put this past all doubt; which being somewhat similar to those of the great Boyle, who pressed it with weights properly applied, carry sufficient conviction.

What has been hitherto related, is chiefly applicable to the element of water alone; but its fluidity is a property that it possesses in common with several other substances, in other respects greatly differing from it. That quality which gives rise to the definition of a fluid, namely, that its parts are in a continual intestine motion, seems extremely applicable to water. What the shapes of those parts are, it would be vain to attempt to discover. Every trial only shews the futility of the attempt; all we find is, that they are extremely minute; and that they roll over each other with the greatest ease. Some, indeed, from this property alone, have not hesitated to pronounce them globular; and we have, in all our hydrostatical books, pictures of these little globes in a state of sliding and rolling over each other. But all this is merely the work of imagination; we know that substances of any kind, reduced very small, assume a fluid appearance, somewhat resembling that of water. Mr. Boyle, after finely powdering and sifting a little dry powder of plaister of Paris, put it in a vessel over the fire, where it soon began to boil like water, exhibiting all the motions and appearances of a boiling liquor. Although but a powder, the parts of which we know are very different from each other, and just as accident has formed them, yet it heaved in great waves, like water. Upon agitation, an heavy body will sink to the bottom, and a light one emerge to the top. There is no reason to suppose the figure of the parts of water round, since we see their fluidity very well imitated by a composition, the parts of which are of various forms and sizes. The shape of the parts of water, therefore, we must be content to continue ignorant of. All we know is, that earth, air, and fire, conduce to separate the parts from each other.

Earthy substances divide the parts from each other, and keep them asunder. This division may be so great, that the water will entirely lose its fluidity thereby. Mud, potter's clay, and dried bricks, are so many different combinations of earth and water; each substance in which the parts of water are most separated from each other, appearing to be



the most dry. In some substances, indeed, where the parts of water are greatly divided, as in porcelain, for instance, it is no easy matter to recover and bring them together again; but they continue in a manner fixed and united to the manufactured clay. This circumstance led Doctor Cheney into a very peculiar strain of thinking. He suspected that the quantity of water, on the surface of the earth, was daily decreasing. For, says he, some parts of it are continually joined to vegetable, animal, and mineral substances, which no art can again recover. United with these, the water loses its fluidity; for if, continues he, we separate a few particles of any fluid, and fasten them to a solid body, or keep them asunder, they will be fluid no longer. To produce fluidity, a considerable number of such particles are required; but here they are close, and destitute of their natural properties. Thus, according to him, the world is growing every day harder and harder, and the earth firmer and firmer; and there may come a time when every object around us may be stiffened in universal frigidity! However, we have causes enough of anxiety in this world already, not to add this preposterous concern to the number.

That air also contributes to divide the parts of water, we can have no manner of doubt; some have even disputed whether water be not capable of being turned into air. Though this cannot be allowed, it must be granted, that it may be turned into a substance which greatly resembles air (as we have seen in the experiment of the æolipile) with all its properties; except that, by cold, this new-made air may be condensed again into water.

But of all the substances which tend to divide the parts of water, fire is the most powerful. Water, when heated into steam, acquires such force, and the parts of it tend to fly off from each other with such violence, that no earthly substance we know of, is strong enough to confine them. A single drop of water, converted into steam, has been found capable of raising a weight of twenty tons; and would have raised twenty thousand, were the vessel confining it sufficiently strong, and the fire below increased in proportion.

From this easy yielding of its parts to external pressure, arises the art of determining the specific gravity of bodies by plunging them in water; with many other useful discoveries in that part of natural philosophy, called hydrostatics. The laws of this science, which Archimedes began, and Pascal, with some other of the moderns, have improved, rather belongs to experimental than to natural history. However, we shall mention some of the most striking paradoxes in this branch of science, which are as well confirmed by experiment, as rendered universal by theory. It would, indeed, be unpardonable, while discoursing on the properties of water, to omit giving some account of the manner in which it sustains such immense bulks as we see floating upon its soft and yielding surface: how some bodies, that are known to sink at one time, swim with ease, if their surface be enlarged: how the heaviest body, even gold itself, may be made to swim upon water; and how the lightest, such as cork, shall remain sunk at the bottom: how the pouring in of a single quart of water, will burst an hoghead hooped with iron: and how it ascends, in pipes, from the valley, to travel over the mountain: these are circumstances, that are at first surprising; but, upon a slight consideration, lose their wonder.

In order to conceive the manner in which all these wonders are effected, we must begin by observing that water is possessed of an invariable property, which has not hitherto been mentioned, that of always keeping its surface level and even. Winds, indeed, may raise it into waves; or art spurt it up in fountains; but ever, when left to itself, it sinks

into a smooth even surface, of which no one part is higher than another. If any one should pour water, for instance, into the arm of a pipe of the shape of the letter U, the fluid would rise in the other arm just to the same height; because, otherwise, it would not find its level, which it invariably maintains. A pipe bending from one hill down into the valley, and rising by another, may be considered as a tube of this kind, in which the water, sinking in one arm, rises to maintain its level in the other. Upon this principle all water-pipes depend; which can never raise the water higher than the fountain from which they proceed.

Again, let us suppose for a moment, that the arms of the pipe already mentioned, may be made long or short at pleasure; and let us still further suppose, that there is some obstacle at the bottom of it, which prevents the water poured into one arm, from rising in the other. Now it is evident, that this obstacle at the bottom will sustain a pressure from the water in one arm, equal to what would make it rise in the other; and this pressure will be great, in proportion as the arm filled with water is tall. We may, therefore, generally conclude, that the bottom of every vessel is pressed by a force, in proportion to the height of the water in that vessel. For instance, if the vessel filled with water be forty feet high, the bottom of that vessel will sustain such a pressure as would raise the same water forty feet high, which is very great. From hence we see how extremely apt our pipes that convey water to the city are to burst; for descending from an hill of more than forty feet high, they are pressed by the water contained in them, with a force equal to what would raise it more than forty feet high; and that this is sometimes able to burst a wooden pipe, we can have no room to doubt of.

Still recurring to our pipe, let us suppose one of its arms ten times as thick as the other; this will produce no effect whatsoever upon the obstacle below, which we supposed hindering its rise in the other arm; because, how thick soever the pipe may be, its contents would only rise to its own level; and it will, therefore, press the obstacle with an equal force. We may, therefore, universally conclude, that the bottom of any vessel is pressed by its water, not as it is broad or narrow, but in proportion as it is high. Thus the water contained in a vessel not thicker than one's finger, presses its bottom as forcibly as the water contained in an hoghead of an equal height; and, if we made holes in the bottoms of both, the water would burst out as forceful from the one as the other. Hence we may, with great ease, burst an hoghead with a single quart of water, and it has been often done. We have only, for this, to place an hoghead on one end, filled with water; we then bore an hole in its top, into which we plant a narrow tin pipe, of about thirty feet high: by pouring a quart of water into this, at the top, as it continues to rise higher in the pipe, it will press more forcibly on the bottom and sides of the hoghead below, and at last burst it.

Still returning to our simple instrument of demonstration. If we suppose the obstacle at the bottom of the pipe to be moveable, so as that the force of the water can push it up into the other arm; such a body is quicksilver, for instance. Now, it is evident, that the weight of water, weighing down upon this quicksilver in one arm, will at last press it up in the other arm, and will continue to press it upwards, until the fluid in both arms be upon a par. So that here we actually see quicksilver, the heaviest substance in the world, except gold, floating upon water, which is but a very light substance.

When we see water thus capable of sustaining quicksilver, we need not be surprised that it is capable of floating much lighter substances, ships, animals,



animals; or timber. When any thing floats upon water, we always see that a part of it sinks in the same. A cork, a ship, a buoy, each buries itself a bed on the surface of the water; this bed may be considered as so much water displaced; the water will, therefore, lose so much of its own weight as is equal to the weight of that bed of water which it displaces. If the body be heavier than a similar bulk of water, it will sink; if lighter, it will swim. Universally, therefore, a body plunged in water, loses as much of its weight as is equal to the weight of a body of water of its own bulk. Some light bodies, therefore, such as cork, lose much of their weight, and therefore swim; other more ponderous bodies sink, because they are heavier than their bulk of water.

Upon this simple theorem entirely depends the art of weighing metals hydrostatically. A person has a guinea, for instance, and desires to know whether it be pure gold: it has been weighed in the usual way with another guinea, and been found exactly of the same weight, but still there is some suspicion, from its greater bulk, that it is not pure. In order to determine this, there is nothing more to be done than to weigh it in water with that same guinea that is known to be good, and of the same weight; and this will instantly shew the difference; for the true ponderous metal will sink, and the false bulky one will be sustained in proportion to the greatness of its surface. Those whose business it is to examine the purity of metals, have a balance made for this purpose, by which they can precisely determine which is most ponderous, or, as it is expressed, which has the greatest specific gravity. Seventy-one pound and an half of quicksilver is found to be equal in bulk to an hundred pound weight of gold. In the same proportion, sixty of lead, fifty-four of silver, forty-seven of copper, forty-five of brass, forty-two of iron, and thirty-nine of tin, are each equal to an hundred pound of the most ponderous of all metals.

This method of precisely determining the purity of gold, by weighing in water, was first discovered by Archimedes, to whom mankind have been indebted for many useful discoveries. Hiero, king of Sicily, having sent a certain quantity of gold to be made into a crown, the workman, it seems, kept a part for his own use, and supplied the deficiency with a baser metal. His fraud was suspected by the king, but could not be detected, till he applied to Archimedes, who weighed the crown in water; and, by this method, informed the king of the quantity of gold which was taken away.

It has been said, that all fluids endeavour to preserve their level; and, likewise, that a body pressing on the surface, tended to destroy that level. From hence it will easily be inferred, that the deeper any body sinks, the greater will be the resistance of the depressed fluid beneath. It will be asked, therefore, as the resistance increases in proportion as the body descends, how comes the body, after it is got a certain way, to sink at all? The answer is obvious. From the fluid above pressing it down with almost as great a force as the fluid beneath presses it up. Take away, by any art, the pressure of the fluid from above, and let only the resistance of the fluid from below be suffered to act, and after the body is got down very deep, the resistance will be insuperable. To give an instance: a small hole opens in the bottom of a ship at sea, forty feet we will suppose below the surface of the water; through this the water bursts up with great violence; a person attempts to stop it with his hand, but it pushes the hand violently away. Here the hand is, in fact, a body attempting to sink upon water, at a depth of forty feet, with the pressure from above taken away. The water, therefore, will overcome his strength; and will continue to burst in till it has got to its level:

if he should then dive into the hold, and clap his hand upon the opening, as before, he shall perceive no force acting against his hand at all, for the water above presses the hand as much down against the hole, as the water without presses it upward. For this reason also, when we dive to the bottom of the water, we sustain a very great pressure from above, it is true, but it is counteracted by the pressure from below; and the whole acting uniformly on the surface of the body, wraps us close round without injury.

As we have deviated thus far, we will just mention one or two properties more, which water, and all such like fluids, is found to possess. And first, their ascending in vessels which are emptied of air, as in our common pumps for instance. The air, however, being the agent in this case, we must previously examine its properties, before we undertake the explanation. The other property to be mentioned is, that of their ascending in small capillary tubes. This is one of the most extraordinary and inscrutable appearances in nature. Glass tubes may be drawn, by means of a lamp, as fine as an hair; still preserving their hollow within. If one of these be planted in a vessel of water, or spirit of wine, the liquor will immediately be seen to ascend; and it will rise higher, in proportion as the tube is smaller; a foot, two feet, and more. How does this come to pass? Is the air the cause? No: the liquor rises, although the air be taken away. Is attraction the cause? No: for quicksilver does not ascend, which it otherwise would. Many have been the theories of experimental philosophers to explain this property. Such as are fond of travelling in the regions of conjecture, may consult Hawksbee, Morgan, Jurin, or Watson, who have examined the subject with great minuteness. Hitherto, however, nothing but doubts instead of knowledge have been the result of their enquiries. It will not, therefore, become us to enter into the minuteness of the enquiry, when we have so many greater wonders to call our attention away.

#### CHAP. XIV.

##### Of the Origin of RIVERS.

THE sun riseth, and the sun goeth down, and pants for the place from whence he arose. All things are filled with labour, and man cannot utter it. All rivers run into the sea, yet the sea is not full. Unto the place whence the rivers come, thither they return again. The eye is not satisfied with seeing, nor the ear with hearing. Thus speaks the wisest of the Jews. And, at so early a period was the curiosity of man employed in observing these great circulations of nature? Every eye attempted to explain those appearances; and every philosopher who has long thought upon the subject, seems to give a peculiar solution. The enquiry whence rivers are produced, whence they derive those unceasing stores of water, which continually enrich the world with fertility and verdure; has been variously considered; and divided the opinions of mankind, more than any other topic in natural history.

In this contest, the various champions may be classed under two leaders. Mr. De La Hire, who contends that rivers must be supplied from the sea, strained through the pores of the earth; and Doctor Halley, who has endeavoured to demonstrate, that the clouds alone are sufficient for the supply. Both sides have brought in mathematics to their aid, and have shewn, that long and laborious calculations can at any time be made, to obscure both sides of a question.

De La Hire begins his proofs, that rain-water, evaporated



evaporated from the sea, is insufficient for the production of rivers; by shewing, that rain never penetrates the surface of the earth above sixteen inches. From thence he infers, that it is impossible for it, in many cases, to sink so as to be found at such considerable depths below. Rain-water, he grants, is often seen to mix with rivers, and to swell their currents; but a much greater part of it evaporates. In fact, continues he, if we suppose the earth every where covered with water, evaporation alone would be sufficient to carry off two feet nine inches of it in a year; and yet, we very well know, that scarce nineteen inches of rain-water falls in that time; so that evaporation would carry off a much greater quantity than is ever known to descend. The small quantity of rain-water that falls is therefore but barely sufficient for the purposes of vegetation. Two leaves of a fig-tree have been found, by experiment, to imbibe from the earth, in five hours and an half, two ounces of water. This implies the great quantity of fluid that must be exhausted in the maintenance of one single plant. Add to this, that the waters of the river Rungis will, by calculation, rise to fifty inches; and the whole country from whence they are supplied, never receives fifty inches, in the year, by rain. Besides this, there are many salt springs, which are known to proceed immediately from the sea, and are subject to its flux and reflux. In short, wherever we dig beneath the surface of the earth, except in a very few instances, water is to be found; and it is by this subterraneous water, that springs and rivers, nay, a great part of vegetation itself, is supported. It is this subterraneous water, which is raised into steam, by the internal heat of the earth, that feeds plants. It is this subterraneous water that distils through its interstices; and there cooling, forms fountains. It is this that, by the addition of rains, is increased into rivers; and pours plenty over the whole earth.

On the other side of the question, it is asserted, that the vapours which are exhaled from the sea, and driven by the winds upon land, are more than sufficient to supply not only plants with moisture, but also to furnish a sufficiency of water to the greatest rivers. For this purpose, an estimate has been made of the quantity of water emptied at the mouth of the greatest rivers; and of the quantity also raised from the sea by evaporation; and it has been found, that the latter by far exceeds the former. This calculation was made by Mr. Mariotte. By him it was found, upon receiving such rain as fell in a year, in a proper vessel, fitted for that purpose, that, one year with another, there might fall about twenty inches of water upon the surface of the earth, throughout Europe. It was also computed, that the river Seine, from its source to the city of Paris, might cover an extent of ground, that would supply it annually with above seven millions of cubic feet of this water, formed by evaporation. But, upon computing the quantity which passed through the arches of one of its bridges in a year, it was found to amount only to two hundred and eighty millions of cubic feet, which is not above the sixth part of the former number. Hence it appears, that this river may receive a supply brought to it by the evaporated waters of the sea, six times greater than what it gives back to the sea by its current; and, therefore, evaporation is more than sufficient for maintaining the greatest rivers; and supplying the purposes also of vegetation.

In this manner, the sea furnishes sufficient humidity to the air for furnishing the earth with all necessary moisture. One part of its vapours fall upon its own bosom, before they arrive upon land. Another part is arrested by the sides of mountains, and is compelled, by the rising stream of air, to mount upward towards the summits. Here it is presently

precipitated, dripping down by the crannies of the stone. In some places, entering into the caverns of the mountain, it gathers in those receptacles, which being once filled, all the rest overflows; and breaking out by the sides of the hills, forms single springs. Many of these run down by the valleys, or gûts, between the ridges of the mountain, and form little rivulets or brooks; many of these meeting in one common valley, and gaining the plain ground, being grown less rapid, become a river; and many of these uniting, make such vast bodies of water as the Rhine, the Rhone, and the Danube.

There is still a third part, which falls upon the lower grounds, and furnishes plants with their wonted supply. But the circulation does not rest even here; for it is again exhaled into vapour by the action of the sun; and afterwards returned to that great mass of waters whence it first arose. This, adds Doctor Halley, seems the most reasonable hypothesis; and much more likely to be true, than that of those who derive all springs from the filtering of the sea waters through certain imaginary tubes or passages within the earth; since it is well known, that the greatest rivers have their most copious fountains the most remote from the sea.

This seems the most general opinion; and yet, after all, it is still pressed with great difficulties; and there is still room to look out for a better theory. The perpetuity of many springs, which always yield the same quantity when the least rain or vapour is afforded, as well as when the greatest, is a strong objection. Derham mentions a spring at Upminster, which he could never perceive by his eye to be diminished, in the greatest droughts, even when all the ponds in the country, as well as an adjoining brook, have been dry for several months together. In the rainy seasons also, it was never overflowed; except sometimes, perhaps, for an hour or so, upon the immersion of the external rains. He, therefore, justly enough concludes, that had this spring its origin from rain or vapour, there would be found an increase or decrease of its water, corresponding to the causes of its production.

Thus the reader, after having been tossed from one hypothesis to another, must at last be contented to settle in conscious ignorance. All that has been written upon this subject, affords him rather something to say, than something to think; something rather for others than for himself. Varenus, indeed, although he is at a loss for the origin of rivers, is by no means so as to their formation. He is pretty positive that all rivers are artificial. He boldly asserts, that their channels have been originally formed by the industry of man. His reasons are, that when a new spring breaks forth, the water does not make itself a new channel, but spreads over the adjacent land. Thus, says he, men are obliged to direct its course; or, otherwise, Nature would never have found one. He enumerates many rivers, that are certainly known, from history, to have been dug by men. He alledges, that no salt-water rivers are found, because men did not want salt-water; and as for salt, that was procurable at a less expence than digging a river for it. However, it costs a speculative man but a small expence of thinking to form such an hypothesis. It may, perhaps, engross the reader's patience to detain him longer upon it.

Nevertheless, though philosophy be thus ignorant, as to the production of rivers, yet the laws of their motion, and the nature of their currents, have been very well explained. The Italians have particularly distinguished themselves in this respect; and it is chiefly to them that we are indebted for the improvement.

All rivers have their source, either in mountains, or elevated lakes; and it is in their descent from these,



these, that they acquire that velocity which maintains their future current. At first their course is generally rapid and headlong; but it is retarded in its journey by the continual friction against its banks, by the many obstacles it meets to divert its stream, and by the plains generally becoming more level as it approaches towards the sea.

If this acquired velocity be quite spent, and the plain through which the river passes is entirely level, it will, notwithstanding, still continue to run from the perpendicular pressure of the water, which is always in exact proportion to the depth. This perpendicular pressure is nothing more than the weight of the upper waters pressing the lower out of their places, and, consequently, driving them forward, as they cannot recede against the stream. As this pressure is greatest in the deepest parts of the river, so we generally find the middle of the stream most rapid; both because it has the greatest motion thus communicated by the pressure, and the fewest obstructions from the banks on either side.

Rivers thus set into motion are almost always found to make their own beds. When they find the bed elevated, they wear its substance away, and deposit the sediment in the next hollow, so as in time to make the bottom of their channels even. On the other hand, the water is continually gnawing and eating away the banks on each side; and this with more force as the current happens to strike more directly against them. By these means, it always has a tendency to render them more strait and parallel to its own course. Thus it continues to rectify its banks, and enlarge its bed; and, consequently, to diminish the force of its stream, till there becomes an equilibrium between the force of the water, and the resistance of its banks, upon which both will remain without any further mutation. And it is happy for man that bounds are thus put to the erosion of the earth by water; and that we find all rivers only dig and widen themselves but to a certain degree.

In those plains and large valleys where great rivers flow, the bed of the river is usually lower than any part of the valley: but it often happens, that the surface of the water is higher than many of the grounds that are adjacent to the banks of the stream. If, after inundations, we take a view of some rivers, we shall find their banks appear above water, at a time that all the adjacent valley is overflowed. This proceeds from the frequent deposition of mud, and such like substances, upon the banks, by the rivers frequently overflowing; and thus, by degrees, they become elevated above the plain; and the water is often seen higher also.

Rivers, as every body has seen, are always broadest at the mouth; and grow narrower towards their source. But what is less known, and probably more deserving curiosity, is, that they run in a more direct channel as they immediately leave their sources; and that their sinuosities and turnings become more numerous as they proceed. It is a certain sign among the savages of North America, that they are near the sea, when they find the rivers winding, and every now and then changing their direction. And this is even now become an indication to the Europeans themselves, in their journeys through those trackless forests. As those sinuosities, therefore, increase as the river approaches the sea, it is not to be wondered at, that they sometimes divide, and thus disembody by different channels. The Danube disembody into the Euxine by seven mouths; the Nile, by the same number; and the Wolga, by seventy.

The currents of rivers, are to be estimated very differently from the manner in which those writers, who have given us mathematical theories on this subject, represent them. They found their cal-

culations upon the surface being a perfect plain, from one bank to the other; but this is not the actual state of nature; for rivers, in general, rise in the middle; and this convexity is greatest in proportion as the rapidity is greater. Any person, to be convinced of this, need only lay his eye as nearly as he can on a level with the stream, and looking across to the opposite bank, he will perceive the river in the midst to be elevated considerably above what it is at the edges. This rising, in some rivers, is often found to be three feet high; and is ever increased, in proportion to the rapidity of the stream. In this case, the water in the midst of the current loses a part of its weight, from the velocity of its motion; while that at the sides, for the contrary reason, sinks lower. It sometimes, however, happens, that this appearance is reversed; for when tides are found to flow up with violence against the natural current of the water, the greatest rapidity is then found at the sides of the river, as the water there resists the influx from the sea. On those occasions, therefore, the river presents a concave rather than a convex surface; and, as in the former case, the middle waters rose in a ridge; in this case, they sink in a furrow.

The stream of all rivers is more rapid in proportion as its channel is diminished. For instance, it will be much swifter where it is ten yards broad, than where it is twenty; for the force behind still pushing the water forward, when it comes to the narrow part, it must make up by velocity what it wants in room.

It often happens that the stream of a river is opposed by one of its jutting banks, by an island in the midst, the arches of a bridge, or some such obstacle. This produces, not unfrequently, a back current; and the water having past the arch with great velocity, pushes the water on each side of its direct current.

This produces a side current, tending to the banks, and not unfrequently a whirlpool; in which a large body of waters are circulated in a kind of cavity, sinking down in the middle. The central point of the whirlpool is always lowest, because it has the least motion: the other parts are supported, in some measure, by the violence of theirs; and, consequently, rise higher as their motion is greater; so that towards the extremity of the whirlpool must be higher than towards the center.

If the stream of a river be stopped at the surface, and yet be free below; for instance, if it be laid over by a bridge of boats, there will then be a double current; the water at the surface will flow back, while that at the bottom will proceed with increased velocity. It often happens that the current at the bottom is swifter than at the top, when, upon violent land-floods, the weight of waters towards the source presses the waters at the bottom, before it has had time to communicate its motion to the surface. However, in all other cases, the surface of the stream is swifter than the bottom, as it is not retarded by rubbing over the bed of the river.

It might be supposed that bridges, dams, and other obstacles in the current of a river, would retard its velocity: but the difference they make is very inconsiderable. The water, by these stoppages, gets an elevation above the object; which, when it has surmounted, it gives a velocity that recompences the former delay. Islands and turnings also retard the course of the stream but very inconsiderably; any cause which diminishes the quantity of the water, most sensibly diminishes the force and the velocity of the stream.

An increase of water in the bed of the river always increases its rapidity, except in cases of inundation. The instant the river has overflowed its banks,



banks, the velocity of its current is always turned that way, and the inundation is perceived to continue for some days; which it would not otherwise do, if, as soon as the cause was discontinued, it acquired its former rapidity.

A violent storm, that sets directly up against the course of the stream, will always retard, and sometimes entirely stop its course. We have seen an instance of this, when the bed of a large river was left entirely dry for some hours; and fish were caught among the stones at the bottom.

Inundations are generally greater towards the source of rivers, than farther down; because the current is generally swifter below than above; and that for the reason already assigned.

A little river may be received into a large one, without augmenting either its width or depth. This, which at first view seems a paradox, is yet very easily accounted for. The little river, in this case, only goes towards increasing the swiftness of the larger, and putting its dormant waters into motion. In this manner, the Venetian branch of the Po was pushed on by the Ferarese branch and that of Panaro, without any enlargement of its breadth or depth from these accessions.

A river tending to enter another, either perpendicularly, or in an opposite direction, will be diverted, by degrees, from that direction; and be obliged to make itself a more favourable entrance downward, and more conspiring with the stream of the former.

The union of two rivers into one, makes it flow the swifter; since the same quantity of water, instead of rubbing against four shores, now only rubs against two. And, besides, the current being deeper, becomes of consequence more fitted for motion.

With respect to the places from whence rivers proceed, it may be taken for a general rule, that the largest and highest mountains supply the greatest and most extensive rivers. It may also be remarked, in whatever direction the ridge of the mountain runs, the river takes an opposite course. If the mountain, for instance, stretches from north to south, the river runs from east to west; and so contrariwise. These are some of the most generally received opinions with regard to the course of rivers; however, they are liable to many exceptions; and nothing but an actual knowledge of each particular river can furnish us with an exact theory of its current.

The largest rivers of Europe are, first, the Wolga, which is about six hundred and fifty leagues in length, extending from Reschow to Astrachan. It is remarkable of this river, that it abounds with water during the summer months of May and June; but all the rest of the year is so shallow as scarce to cover its bottom, or allow a passage for loaded vessels that trade up its stream. It was up this river that the English attempted to trade into Persia, in which they were so unhappily disappointed, in the year 1741. The next in order is the Danube. The course of this is about four hundred and fifty leagues, from the mountains of Switzerland to the Black Sea. It is so deep between Buda and Belgrade, that the Turks and Christians have fleets of men of war upon it, which frequently engaged, during the last war between the Ottomans and the Austrians: however, it is unnavigable further down, by reason of its cataracts, which prevent its commerce into the Black Sea. The Don, or Tanaïs, which is four hundred leagues from the source of that branch of it called the Sofna, to its mouth in the Euxine sea. In one part of its course it approaches near the Wolga; and Peter the Great had actually begun a canal, by which he intended joining those two rivers; but this he did not live to finish. The Nieper, or Boristhenes, which rises in the middle of Muscovy, and runs a course of

three hundred and fifty leagues, to empty itself into the Black Sea. The Old Cossacks inhabit the banks and islands of this river; and frequently cross the Black Sea, to plunder the maritime places on the coasts of Turkey. The Dwina, which takes its rise in a province of the same name in Russia, that runs a course of three hundred leagues, and disembogues into the White Sea, a little below Archangel.

The largest rivers of Asia are, the Hoanho, in China, which is eight hundred and fifty leagues in length, computing from its source at Raja Ribron, to its mouth in the Gulph of Changli. The Jenisca of Tartary, about eight hundred leagues in length, from the Lake Selinga to the Icy Sea. This river is, by some, supposed to supply most of that great quantity of drift wood which is seen floating in the seas, near the Arctic circle. The Oby, of five hundred leagues, running from the lake of Kila into the Northern sea. The Amour, in Eastern Tartary, whose course is about five hundred and seventy-five leagues, from its source to its entrance into the sea of Kamtschatka. The Kiam, in China, five hundred and fifty leagues in length. The Ganges, one of the most noted rivers in the world, and about as long as the former. It rises in the mountains which separate India from Tartary; and running through the dominions of the Great Mogul, discharges itself by several mouths into the bay of Bengal. It is not only esteemed by the Indians for the depth, and pureness of its stream, but for a supposed sanctity which they believe to be in its waters. It is visited annually by several hundred thousand pilgrims, who pay their devotions to the river as to a god; for savage simplicity is always known to mistake the blessings of the Deity for the Deity himself. They carry their dying friends from distant countries, to expire on its banks; and to be buried in its stream. The water is lowest in April or May; but the rains beginning to fall soon after, the flat country is overflowed for several miles, till about the end of September; the waters then begin to retire, leaving a prolific sediment behind, that enriches the soil, and, in a few days time, gives a luxuriance to vegetation, beyond what can be conceived by an European. Next to this may be reckoned the still more celebrated river Euphrates. This rises from two sources, northward of the city Erzerum, in Turcomania; and unites about three days journey below the same; from whence, after performing a course of five hundred leagues, it falls into the Gulph of Persia, fifty miles below the city of Bassora in Arabia. The river Indus is extended from its source to its discharge into the Arabian sea, four hundred leagues.

The largest rivers of Africa are, the Senegal, which runs a course of not less than eleven hundred leagues, comprehending the Niger, which some have supposed to fall into it. However, later accounts seem to affirm that the Niger is lost in the sands, about three hundred miles up from the western coasts of Africa. Be this as it may, the Senegal is well known to be navigable for more than three hundred leagues up the country; and how much higher it may reach is not yet discovered, as the dreadful fatality of the inland parts of Africa, not only deter curiosity, but even avarice, which is a much stronger passion. At the end of last war, of fifty Englishmen that were sent to the factory at Galam, a place taken from the French, and nine hundred miles up the river, only one returned to tell the fate of his companions, who were destroyed by the climate. The celebrated river Nile is said to be nine hundred and seventy leagues, from its source among the mountains of the Moon, in Upper Ethiopia, to its opening into the Mediterranean



terrestrial sea. The sources of this river were considered as inferutable by the ancients; and the causes of its periodical inundation were equally known. They have both been ascertained by the missionaries who have travelled into the interior parts of Ethiopia. The Nile takes its rise in the kingdom of Gojam, from a small aperture on the top of a mountain, which, though not above a foot and an half over, yet was unfathomable. This fountain, when arrived at the foot of the mountain, expands into a river; and being joined by others, forms a lake thirty leagues long, and as many broad; from this, its channel, in some measure, winds back to the country where it first began; from thence, precipitating by frightful cataracts, it travels through a variety of desert regions, equally formidable, such as Amhara, Olaca, Damot, and Xaoa. Upon its arrival in the kingdom of Upper Egypt, it runs through a rocky channel, which some late travellers have mistaken for its cataracts. In the beginning of its course, it receives many lesser rivers into it; and Pliny was mistaken, in saying that it received none. In the beginning also of its course, it has many windings; but, for above three hundred leagues from the sea, runs in a direct line. Its annual overflowings arise from a very obvious cause, which is almost universal with the great rivers that take their source near the Line. The rainy season, which is periodical in those climates, flood the rivers; and as this always happens in our summer, so the Nile is at that time overflowed. From these inundations, the inhabitants of Egypt derive happiness and plenty; and, when the river does not arise to its accustomed heights, they prepare for an indifferent harvest. It begins to overflow about the seventeenth of June; it generally continues to augment for forty days, and decreases in about as many more. The time of increase and decrease, however, is much more inconsiderable now than it was among the ancients. Herodotus informs us, that it was an hundred days rising, and as many falling; which shews that the inundation was much greater at that time than at present. Mr. Buffon has ascribed the present diminution, as well to the lessening of the mountains of the Moon, by their substance having so long been washed down with the stream, as to the rising of the earth in Egypt, that has for so many ages received this extraneous supply. But we do not find, by the buildings that have remained since the times of the ancients, that the earth is much raised since then. Besides the Nile in Africa, we may reckon the Zara, and the Coanza, from the greatness of whose openings into the sea, and the rapidity of whose streams, we form an estimate of the great distance from whence they come. Their courses, however, are spent in watering deserts and savage countries, whose poverty or fierceness have kept strangers away.

But of all parts of the world, America, as it exhibits the most lofty mountains, so also it supplies the largest rivers. The foremost of these is the great river Amazons, which, from its source in the lake of Lauricocha, to its discharge into the Western Ocean, performs a course of more than twelve hundred leagues. The breadth and depth of this river is answerable to its vast length; and, where its width is most contracted, its depth is augmented in proportion. So great is the body of its waters, that other rivers, though before the objects of admiration, are lost in its bosom. It proceeds, after their junction, with its usual appearance, without any visible change in its breadth or rapidity; and, if we may so express it, remains great without ostentation. In some places it displays its whole magnificence, dividing into several large branches, and encompassing a multitude of

islands; and, at length, discharging itself into the ocean, by a channel of an hundred and fifty miles broad. Another river, that may almost rival the former, is the St. Lawrence, in Canada; which rising in the lake Assiniboils, passes from one lake to another, from Cristinaux to Alempigo; from thence to lake Superior; thence to the lake Hurons; to lake Erie; to lake Ontario; and, at last, after a course of nine hundred leagues, pours their collected waters into the Atlantic ocean. The river Mississippi is of more than seven hundred leagues in length, beginning at its source near the lake Assiniboils, and ending at its opening into the Gulf of Mexico. The river Plate runs a length of more than eight hundred leagues from its source in the river Parana, to its mouth. The river Oroonoko is seven hundred and fifty-five leagues in length, from its source near Pasto, to its discharge into the Atlantic ocean.

Such is the amazing length of the greatest rivers; and even in some of these, the most remote sources very probably yet continue unknown. In fact, if we consider the number of rivers which they receive, and the little acquaintance we have with the regions through which they run, it is not to be wondered at that geographers are divided concerning the sources of most of them. As among a number of roots by which nourishment is conveyed to a stately tree, it is difficult to determine precisely that by which the tree is chiefly supplied; so among the many branches of a great river, it is equally difficult to tell which is the original. Hence it may easily happen, that a similar branch is taken for the capital stream; and its runnings are pursued, and delineated, in prejudice of some other branch that better deserved the name and the description. In this manner, in Europe, the Danube is known to receive thirty lesser rivers: the Wolga, thirty-two or thirty-three. In Asia, the Hohanno receives thirty-five; the Jenisca above sixty; the Oby as many; the Amour about forty; the Nanquin receives thirty rivers; the Ganges twenty; and the Euphrates about eleven. In Africa, the Senegal receives more than twenty rivers; the Nile receives not one for five hundred leagues upwards, and then only twelve or thirteen. In America, the river Amazons receives above sixty, and those very considerable; the river St. Lawrence about forty, counting those which fall into its lakes; the Mississippi receives forty; and the river Plate above fifty.

We mentioned the inundations of the Ganges and the Nile, but almost every other great river whose source lies within the tropics, have their stated inundations also. The river Pegu has been called, by travellers, the Indian Nile, because of the similar overflowings of its stream: this it does to an extent of thirty leagues on each side; and so fertilizes the soil, that the inhabitants send great quantities of rice into other countries; and have still abundance for their own consumption. The river Senegal has likewise its inundations, which cover the whole flat country of Negroland, beginning and ending much about the same time with those of the Nile; as, in fact, both rivers rise from the same mountains. But the difference between the effects of the inundations in each river is remarkable: in the one, it distributes health and plenty; in the other, diseases, famine, and death. The inhabitants along the torrid coasts of the Senegal can receive no benefit from any additional manure the river may carry down to their soil, which is, by nature, more than sufficiently luxuriant; or, even if they could, they have not industry to turn it to any advantage. The banks, therefore, of the rivers, lie uncultivated, overgrown with rank and noxious herbage, and infested with thou-  
sands



sands of animals of various malignity. Every new flood only tends to increase the rankness of the soil, and to provide fresh shelter for the creatures that infest it. If the flood continues but a few days longer than usual, the improvident inhabitants, who are driven up in the higher grounds, want provisions, and a famine ensues. When the river begins to return into its channel, the humidity and heat of the air are equally fatal; and the carcases of infinite numbers of animals, swept away by the inundation, putrifying in the sun, produce a stench that is almost insupportable. But even the luxuriance of the vegetation becomes a nuisance. We have been assured by persons of veracity who have been up the river Seriegai, that there are some plants growing along the coast, the smell of which is so powerful, that it is hardly to be endured. It is certain, that all the sailors and soldiers who have been at any of our factories there, ascribe the unwholesomeness of the voyage up the stream, to the vegetable vapour. However this be, the inundations of the rivers in this wretched part of the globe, contribute scarce any advantage, if we except to the beauty of the prospects which they afford. These, indeed, are finished beyond the utmost reach of art: a spacious glassy river, with its banks here and there fringed to the very surface by the mangrove-tree, that grows down into the water, presents itself to view. Lofty forests of various colours, with openings between, carpeted with green plants, and the most gaudy flowers; beasts and animals, of various kinds, that stand upon the banks of the river, and, with a sort of wild curiosity, survey the mariners as they pass, contribute to heighten the scene. This is the sketch of an African prospect; which delights the eye, even while it destroys the constitution.

Beside these annually periodical inundations, there are many rivers that overflow at much shorter intervals. Thus most of those in Peru and Chili have scarce any motion by night; but upon the appearance of the morning sun, they resume their former rapidity: this proceeds from the mountain snows, which melting with the heat, increase the stream, and continue to drive on the current while the sun continues to dissolve them. Some rivers also flow with an even steady current, from their source to the sea; others flow with greater rapidity, their stream being poured down in a cataract, or swallowed by the sands, before they reach the sea.

The rivers of those countries that have been least inhabited, are usually more rocky, uneven, and broken into water-falls or cataracts, than those where the industry of man has been more prevalent. Wherever man comes, nature puts on a milder appearance: the terrible and the sublime are exchanged for the gentle and the useful; the cataract is sloped away into a placid stream; and the banks become more smooth and even. It must have required ages to render the Rhone or the Loir navigable; their beds must have been cleaned and directed; their inequalities removed; and, by a long course of industry, nature must have been taught to conspire with the desires of her controller. Every one's experience must have supplied instances of rivers thus being made to flow more evenly, and more beneficially to mankind; but there are some whose currents are so rapid, and falls so precipitate, that no art can obviate; and that must for ever remain as amazing instances of incorrigible nature.

Of this kind are the cataracts of the Rhine; one of which has been seen to exhibit a very strange appearance: it was that at Schathausen, which was frozen quite across, and the water stood in columns where the cataract had formerly fallen. The Nile, as was said, has its cataracts. The river Vologa, in Russia, has two. The river

Zara, in Africa, has one near its source. The river Velino, in Italy, has a cataract of above an hundred and fifty feet perpendicular. Near the city of Gottenburgh, in Sweden, the river rushes down from a prodigious high precipice into a deep pit, with a terrible noise, and such dreadful force, that those trees designed for the masts of ships, which are floated down the river, are usually turned upside down in their fall, and often are shattered to pieces, by being dashed against the surface of the water in the pit; this occurs if the masts fall sideways upon the water; but if they fall endways, they dive so far under water, that they disappear for a quarter of an hour, or more: the pit into which they are thus plunged, has been often sounded with a line of some hundred fathoms long, but no ground has been found hitherto. There is also a cataract at Powerscourt, in Ireland, in which the water is said to fall three hundred feet perpendicular; which is a greater descent than that of any other cataract in any part of the world. There is a cataract at Albany, in the province of New York, which pours its stream fifty feet perpendicular. But of all the cataracts in the world, that of Niagara, in Canada, if we consider the great body of water that falls, must be allowed to be the greatest, and the most astonishing.

This amazing fall of water is made by the river St. Lawrence, in its passage from the lake Erie into the lake Ontario. We have already said that St. Lawrence was one of the largest rivers in the world; and yet the whole of its waters are here poured down, by a fall of an hundred and fifty feet perpendicular. It is not easy to bring the imagination to correspond with the greatness of the scene; a river extremely deep and rapid, and that serves to drain the waters of almost all North America into the Atlantic ocean, is here poured precipitately down a ledge of rocks, that rise, like a wall, across the whole bed of its stream. The width of the river, a little above, is near three quarters of a mile broad, and the rocks, where it grows narrower, are four hundred yards over. Their direction is not streight across, but hollowing inwards like an horse-shoe; so that the cataract, which bends to the shape of the obstacle, rounding inwards, presents a kind of theatre the most tremendous in nature. Just in the middle of this circular wall of waters, a little island, that has braved the fury of the current, presents one of its points, and divides the stream at top into two; but it unites again long before it has got to the bottom. The noise of the fall is heard at several leagues distance; and the fury of the waters at the bottom of their fall is inconceivable. The dashing produces a mist that rises to the very clouds; and that produces a most beautiful rainbow, when the sun shines. It may easily be conceived, that such a cataract quite destroys the navigation of the stream; and yet some Indian canoes, as it is said, have been known to venture down it with safety.

Of those rivers that lose themselves in the sands, or are swallowed up by chasms in the earth, we have various information. What we are told by the ancients, of the river Alpheus, in Arcadia, that sinks into the ground, and rises again near Syracuse, in Sicily, where it takes the name of Arethusa, is rather more known than credited. But we have better information with respect to the river Tigris being lost in this manner under Mount Taurus; of the Guadalquivir, in Spain, being buried in the sands; of the river Greatah, in Yorkshire, running underground, and rising again; and even of the great Rhine itself, a part of which is no doubt lost in the sands, a little above Leyden. But it ought to be observed of this river, that by much the greatest part arrives at the ocean; for, although



although the ancient channel which fell into the sea, a little to the west of that city, be now entirely choaked up, yet there are still a number of small canals, that carry a great body of waters to the sea: and, besides, it has also two very large openings, the Lech, and the Wal, below Rotterdam, by which it empties itself abundantly.

Be this as it will, nothing is more common in sultry and sandy deserts, than rivers being thus either lost in the sands, or entirely dried up by the sun. And hence we see, that under the Line, the small rivers are but few; for such little streams as are common in Europe, and which with us receive the name of rivers, would quickly evaporate, in those parching and extensive deserts. It is even confidently asserted, that the great river Niger is thus lost before it reaches the ocean; and that its supposed mouths, the Gambia, and the Senegal, are distinct rivers, that come a vast way from the interior parts of the country. It appears, that the rivers under the Line are large; but it is otherwise at the Poles, where they must necessarily be small. In that desolate region, as the mountains are covered with perpetual ice, which melts but little, or not at all, the springs and rivulets are furnished with a very small supply. Here, therefore, men and beasts would perish, and die for thirst, if Providence had not ordered that in the hardest winter, thaws should intervene, which deposit a small quantity of snow-water in pools under the ice; and from this source the wretched inhabitants drain a scanty beverage.

Thus, whatever quarter of the globe we turn to, we shall find new reasons to be satisfied with that part of it in which we reside. Our rivers furnish all the plenty of the African stream, without its inundation; they have all the coolness of the Polar rivulet, with a more constant supply; they may want the terrible magnificence of huge cataracts, or extensive lakes, but they are more navigable, and more transparent; though less deep and rapid than the rivers of the torrid zone, they are more manageable, and only wait the will of man to take their direction. The rivers of the torrid zone, like the monarchs of the country, rule with despotic tyranny, profuse in their bounties, and ungovernable in their rage. The rivers of Europe, like their kings, are the friends, and not the oppressors of the people; bounded by known limits, abridged in the power of doing ill, directed by human sagacity, and only at freedom to distribute happiness and plenty.

#### CHAP. XV.

Of the OCEAN in general; and its Saltness.

**I**N looking upon a map of the world, we find that the ocean occupies considerably more of the globe, than the land is found to do. This immense body of waters is diffused round both the Old and New Continent, to the south; and may surround them also to the north, for what we know; but the ice in those regions has stopped our enquiries. Although the ocean, properly speaking, is but one extensive sheet of waters, continued over every part of the globe, without interruption, and although no part of it is divided from the rest, yet geographers have distinguished it by different names; as the Atlantic or Western Ocean, the Northern Ocean, the Southern Ocean, the Pacific Ocean, and the Indian Ocean. Others have divided it differently, and given other names, as the Frozen Ocean, the Inferior Ocean, or the American Ocean. But all these being arbitrary distinctions, and not of Nature's making, the naturalist may consider them with indifference. In this vast receptacle, almost all the rivers of the

earth ultimately terminate; nor do such great supplies seem to increase its stores; for it is neither apparently swollen by their tribute, nor diminished by their failure; it still continues the same. Indeed, what is the quantity of water of all the rivers and lakes in the world, compared to that contained in this great receptacle? If we should offer to make a rude estimate, we shall find that all the rivers in the world, flowing into the bed of the sea, with a continuance of their present stores, would take up at least eight hundred years to fill it to its present height. For, supposing the sea to be eighty-five millions of square miles in extent, and a quarter of a mile, upon an average, in depth, this, upon calculation, will give above twenty-one millions of cubic miles of water, as the contents of the whole ocean. Now, to estimate the quantity of water which all the rivers supply, take any one of them; the Po, for instance, the quantity of whose discharge into the sea, is known to be one cubic mile of water in twenty-six days. Now it will be found, upon a rude computation, from the quantity of ground the Po, with its influent streams, covers, that all the rivers of the world furnish about two thousand times that quantity of water. In the space of a year, therefore, they will have discharged into the sea about twenty-six thousand cubic miles of water; and not till eight hundred years will they have discharged as much water as is contained in the sea at present. We have not troubled our readers with the odd numbers, lest they should imagine we were giving precision to a subject that is incapable of it.

Thus great is the assemblage of waters diffused round our habitable globe; and yet, immeasurable as they seem, they are mostly rendered subservient to the necessities and the conveniencies of so little a being as man. Nevertheless, if it should be asked whether they be made for him alone, the question is not easily resolved. Some philosophers have perceived so much analogy to man in the formation of the ocean, that they have not hesitated to assert its being made for him alone. The distribution of land and water, say they, is admirable; the one being laid against the other so skilfully, that there is a just equipoise of the whole globe. Thus the Northern Ocean balances against the Southern; and the New Continent is an exact counter-weight to the Old. As to any objection from the ocean's occupying too large a share of the globe, they contend, that there could not have been a smaller surface employed to supply the earth with a due share of evaporation. On the other hand, some take the gloomy side of the question; they either magnify its apparent defects; or assert, that what seems defects to us, may be real beauties to some wiser order of beings. They observe, that multitudes of animals are concealed in the ocean, and but a small part of them are known; the rest, therefore, they fail not to say, were certainly made for their own benefit, and not for ours. How far either of these opinions be just, we will not presume to determine; but of this we are certain, that God has endowed us with abilities to turn this great extent of waters to our own advantage. He has made these things, perhaps, for other uses; but he has given us faculties to convert them to our own. This much agitated question, therefore, seems to terminate here. We shall never know whether the things of this world have been made for our use; but we very well know that we have been made to enjoy them. Let us then boldly affirm, that the earth, and all its wonders are ours; since we are furnished with powers to force them into our service. Man is the lord of all the sublunary creation; the howling savage, the winding serpent, with all the untrameable and rebellious offspring of Nature, are destroyed in the contest, or driven at a distance from his habitations. The extensive and tempestuous ocean, instead of limiting or dividing his power,



power, only serves to assist his industry, and enlarge the sphere of his enjoyments. Its billows, and its monsters, instead of presenting a scene of terror, only call up the courage of this little intrepid being; and the greatest danger that man now fears on the deep, is from his fellow-creatures. Indeed, when we consider the human race as Nature has formed them, there is but very little of the habitable globe that seems made for them. But when we consider them as accumulating the experience of ages, in commanding the earth, there is nothing so great, or so terrible. What a poor contemptible being is the naked savage, standing on the beach of the ocean, and trembling at its tumults! How little capable is he of converting its terrors into benefits; or of saying, behold an element made wholly for my enjoyment! He considers it as an angry deity, and pays it the homage of submission. But it is very different when he has exercised his mental powers; when he has learned to find his own superiority, and to make it subservient to his commands. It is then that his dignity begins to appear, and that the true Deity is justly praised for having been mindful of man; for having given him the earth for his habitation, and the sea for an inheritance.

This power which man has obtained over the ocean, was at first enjoyed in common; and none pretended to a right in that element where all seemed intruders. The sea, therefore, was open to all till the time of the emperor Justinian. His successor Leo granted such as were in possession of the shore, the sole right of fishing before their respective territories. The Thracian Bosphorus was the first that was thus appropriated; and from that time it has been the struggle of most of the powers of Europe to obtain an exclusive right in this element. The Republic of Venice claims the Adriatic. The Danes are in possession of the Baltic. But the English have a more extensive claim to the empire of all the seas, encompassing the kingdoms of England, Scotland, and Ireland; and although these have been long contested, yet they are now considered as their indisputable property. Every one knows that the great power of the nation is exerted on this element; and that the instant England ceases to be superior upon the ocean, its safety begins to be precarious.

It is in some measure owing to our dependence upon the sea, and to our commerce there, that we are so well acquainted with its extent and figure. The bays, gulphs, currents, and shallows of the ocean, are much better known and examined than the provinces and kingdoms of the earth itself. The hopes of acquiring wealth by commerce, has carried man to much greater length than the desire of gaining information could have done. In consequence of this, there is scarce a strait or an harbour, scarce a rock or a quicksand, scarce an inflexion of the shore, or the jutting of a promontory, that has not been minutely described. But as these present very little entertainment to the imagination, or delight to any but those whose pursuits are lucrative, they need not be dwelt upon here. While the merchant and the mariner are solicitous in describing current and soundings, the naturalist is employed in observing wonders, though not so beneficial, yet to him of a much more important nature. The saltiness of the sea seems to be foremost.

Whence the sea has derived that peculiar bitterish saltiness which we find in it, appears, by Aristotle, to have exercised the curiosity of naturalists in all ages. He supposed (and mankind were for ages content with the solution) that the sun continually raised dry saline exhalations from the earth, and deposited them upon the sea; and hence, say his followers, the waters of the sea are more salt at top than at bottom. But, unfortunately for this opinion, neither of the facts is true. Sea salt is not

to be raised by the vapours of the sun; and sea water is not saltier at the top than at the bottom. Father Bohours is of opinion that the Creator gave the waters of the ocean their saltiness at the beginning; not only to prevent their corruption, but to enable them to bear greater burthens. But their saltiness does not prevent their corruption; for stagnant seawater, like fresh, soon grows putrid: and, as for their bearing greater burthens, fresh water answers all the purposes of navigation quite as well. The established opinion, therefore, is that of Boyle, who supposes, "that the sea's saltiness is supplied not only from rocks or masses of salt at the bottom of the sea, but also from the salt which the rains and rivers, and other waters, dissolve in their passage through many parts of the earth, and at length carry with them to the sea." But as there is a difference in the taste of rock-salt found at land, and that dissolved in the waters of the ocean, this may be produced by the plenty of nitrous and bituminous bodies that, with the salts, are likewise washed into that great receptacle. These substances being thus once carried to the sea, must for ever remain there; for they do not rise by evaporation, so as to be returned back from whence they came. Nothing but the fresh waters of the sea rise in vapours; and all the saltiness remains behind. From hence it follows, that every year the sea must become more and more salt; and this speculation Doctor Halley carries so far as to lay down a method of finding out the age of the world by the saltiness of its waters. "For if it be observed," says he, "what quantity of salt is at present contained in a certain weight of water, taken up from the Caspian Sea, for example, and, after some centuries, what greater quantity of salt is contained in the same weight of water, taken from the same place; we may conclude, that in proportion as the saltiness has increased in a certain time, so much must it have increased before that time; and we may thus, by the rule of proportion, make an estimate of the whole time wherein the water would acquire the degree of saltiness it should be then possessed of." All this may be fine; however, an experiment, begun in this century, which is not to be completed till some centuries hence, is rather a little mortifying to modern curiosity: and, we are induced to think, the inhabitants round the Caspian Sea, will not be apt to undertake the enquiry.

This saltiness is found to prevail in every part of the ocean; and as much at the surface as at the bottom. It is also found in all those seas that communicate with the ocean; but rather in a less degree.

The great lakes, likewise, that have no outlets nor communication with the ocean, are found to be salt: but some of them in less proportion. On the contrary, all those lakes through which rivers run into the sea, however extensive they be, are, notwithstanding, very fresh: for the rivers do not deposit their salts in the bed of the lake, but carry them, with their currents, into the ocean. Thus the lakes Ontario and Erie, in North America, although for magnitude they may be considered as inland seas, are, nevertheless, fresh water lakes; and kept so by the river St. Lawrence, which passes through them. But those lakes that have no communication with the sea, nor any rivers, going out, although they be less than the former, are, however, always salt. Thus, that which goes by the name of the Dead Sea, though very small, when compared to those already mentioned, is so exceedingly salt, that its waters seem scarce capable of dissolving any more. The lakes of Mexico, and of Titicaca, in Peru, though of no great extent, are, nevertheless, salt; and both for the same reason.

Those who are willing to turn all things to the best, have not failed to consider this saltiness of the sea, as a peculiar blessing from Providence, in order



der to keep so great an element sweet and wholesome. What foundation there may be in the remark, we will not pretend to determine; but we shall shortly find a much better cause for its being kept sweet, namely, its motion.

On the other hand, there have been many who have considered the subject in a different light, and have tried every endeavour to make salt-water fresh, so as to supply the wants of mariners in long voyages, or when exhausted of their ordinary stores. At first it was supposed simple distillation would do; but it was soon found that the bitter part of the water still kept mixed. It was then tried by uniting salt of Tartar with sea-water, and distilling both: but here the expence was greater than the advantage. Calcined bones were next thought of; but an hoghead of calcined bones, carried to sea, would take up as much room as an hoghead of water, and was more hard to be obtained. In this state, therefore, have the attempts to sweeten sea-water rested; the chymist satisfied with the reality of his invention; and the mariner convinced of its being useless. We cannot, therefore, avoid mentioning, a kind of succedaneum which has been lately conceived to answer the purposes of fresh-water, when mariners are quite exhausted. It is well known, the persons who go into a warm bath, come out several ounces heavier than they went in; their bodies having imbibed a correspondent quantity of water. This more particularly happens, if they have been previously debarred from drinking, or go in with a violent thirst; which they quickly find quenched, and their spirits restored. It was supposed, that in case of a total failure of fresh-water at sea, a warm bath might be made of sea-water, for the use of mariners; and that their pores would thus imbibe the fluid, without any of its salts, which would be seen to crystallize on the surface of their bodies. In this manner, it is supposed, a sufficient quantity of moisture may be procured to sustain life, till time or accident furnish a more copious supply.

But, however this be, the saltiness of the sea can by no means be considered as a principal cause in preserving its waters from putrefaction. The ocean has its currents, like rivers, which circulate its contents round the globe; and these may be said to be the great agents that keep it sweet and wholesome. Its saltiness alone would by no means answer this purpose: and some have even imagined, that the various substances with which it is mixed, rather tend to promote putrescence than impede it. Sir Robert Hawkins, one of our most enlightened navigators, gives the following account of a calm, in which the sea continuing for some time without motion, began to assume a very formidable appearance. "Were it not," says he, "for the moving of the sea, by the force of winds, tides, and currents, it would corrupt all the world. The experiment of this I saw in the year 1590, lying with a fleet about the islands of Azores, almost six months; the greatest part of which time we were becalmed. Upon which all the sea became so replenished with several sorts of jellies, and forms of serpents, adders, and snakes, as seemed wonderful: some green, some black, some yellow, some white, some of divers colours; and many of them had life; and some there were an yard and an half and two yards long; which had I not seen, I could hardly have believed. And hereof are witnesses all the company of the ships which were then present: so that hardly a man could draw a bucket of water clear of some corruption. In which voyage, towards the end thereof, many of every ship fell sick, and began to die apace. But the speedy passage into our country, was a remedy to the crazed; and a preservative for those that were not touched."

This shews, abundantly, how little the sea's saltiness was capable of preserving it from putrefaction: but, to put the matter beyond all doubt, Mr. Boyle kept a quantity of sea-water, taken up in the English channel, for some time barrelled up; and, in the space of a few weeks, it began to acquire a foetid smell: he was also assured by one of his acquaintance who was becalmed for twelve or fourteen days in the Indian sea, that the water, for want of motion, began to stink; and that had it continued much longer, the stench would probably have poisoned him. It is the motion, therefore, and not the saltiness of the sea, that preserves it in its present state of salubrity; and this, very probably, by dashing and breaking in pieces the rudiments, if we may so call them, of the various animals that would otherwise breed there and putrefy.

There are some advantages, however, which are derived from the saltiness of the sea. Its waters being evaporated, furnish that salt which is used for domestic purposes; and, although in some places it is made from springs, and, in others, dug out of mines, yet the greatest quantity is made only from the sea. That which is called bay-salt, (from its coming to us by the Bay of Biscay) is a stronger kind, made by evaporation in the sun: that called common salt, is evaporated in pans over the fire, and is of a much inferior quality to the former.

Another benefit arising from the quantity of salt dissolved in the sea, is, that it thus becomes heavier, and, consequently, more buoyant. Mr. Boyle, who examined the difference between sea-water and fresh, found that the former appeared to be about a forty-fifth part heavier than the latter. Those, also, who have had opportunities of bathing in the sea, pretend to have experienced a much greater ease in swimming there, than in fresh water. However, as we see they have only a forty-fifth part more of their weight sustained by it, we are apt to doubt whether so minute a difference can be practically perceivable. Be this as it may, as sea-water alters in its weight from fresh, so it is found also to differ from itself in different parts of the ocean. In general, it is perceived to be heavier, and, consequently, saltier, the nearer we approach the Line.

But there is an advantage arising from the saltiness of the waters of the sea, much greater than what has been yet mentioned; which is, that their congelation is thus retarded. Some, indeed, have gone so far as to say, that sea-water never freezes: but this is an assertion contradicted by experience. However, it is certain that it requires a much greater degree of cold to freeze it than fresh water; so that, while rivers and springs are seen converted into one solid body of ice, the sea is always fit for navigation, and no way affected by the coldness of the severest winter. It is, therefore, one of the greatest blessings we derive from this element, that when at land all the stores of Nature are locked up from us, we find the sea ever open to our necessities, and patient of the hand of industry.

But it must not be supposed, because in our temperate climate we never see the sea frozen, that it is in the same manner open in every part of it. A very little acquaintance with the accounts of mariners, must have informed us, that at the polar regions it is embarrassed with mountains, and moving sheets of ice, that often render it impassable. These tremendous floats are of different magnitudes; sometimes rising more than a thousand feet above the surface of the water; sometimes diffused into plains of above two hundred leagues in length; and, in many parts, sixty or eighty broad. They are usually divided by fissures, one piece following another so close, that a person may step from one to the other. Sometimes mountains are seen rising amidst these plains, and presenting the appearance of



of a variegated landscape, with hills and valleys, houses, churches, and towers. These are appearances in which all naturalists are agreed; but the great contest is respecting their formation. Mr. Buffon asserts, that they are formed from fresh water alone; which congealing at the mouths of great rivers, accumulate those huge masses that disturb navigation. However, this great naturalist seems not to have been aware that there are two sorts of ice floating in these seas; the flat ice, and the mountain ice: the one formed of sea-water only; the other, of fresh.

The flat, or driving ice, is entirely composed of sea-water; which, upon dissolution, is found to be salt; and is readily distinguished from the mountain or fresh-water ice, by its whiteness, and want of transparency. This ice is much more terrible to mariners than that which rises up in lumps: a ship can avoid the one, as it is seen at a distance; but it often gets in among the other, which sometimes closing, crushes it to pieces. This, which manifestly has a different origin from the fresh-water ice, may perhaps have been produced in the Icy Sea, beneath the Pole; or along the coasts of Spitzberg, or Nova Zembla.

The mountain-ice, as was said, is different in every respect, being formed of fresh water, and appearing hard and transparent; it is generally of a pale green colour, though some pieces are of a beautiful sky blue; many large masses, also, appear grey; and some black. If examined more nearly, they are found to be incorporated with earth, stones, and brush-wood washed from the shore. On these also are sometimes found, not only earth, but nests with bird eggs, at several hundred miles from land. The generality of these, though almost totally fresh, have, nevertheless, a thick crust of salt-water frozen upon them, probably from the power that ice has sometimes to produce ice. Such mountains as are here described, are most usually seen at spring-time, and after a violent storm, driving out to sea, where they at first terrify the mariner, and are soon after dashed to pieces by the continual washing of the waves; or driven into the warmer regions of the south, there to be melted away. They sometimes, however, strike back upon their native shores, where they seem to take root at the feet of mountains; and, as Martius tells us, are sometimes higher than the mountains themselves. Those seen by him were blue, full of clefts and cavities made by the rain, and crowned with snow, which alternately thawing and freezing every year, augmented their size. These, composed of materials more solid than that driving at sea, presented a variety of agreeable figures to the eye, that, with a little help from fancy, assumed the appearance of trees in blossom; the inside of churches, with arches, pillars, and windows; and the blue coloured rays, darting from within, presented the resemblance of a glory.

If we enquire into the origin and formation of these, which, as we see, are very different from the former, we have a very satisfactory account of them in Krantz's History of Greenland; and we will give the passage, with a very few alterations. "These mountains of ice," says he, "are not salt, like the sea-water, but sweet; and therefore can be formed no where except on the mountains, in rivers, in caverns, and against the hills near the sea-shore. The mountains of Greenland are so high, that the snow which falls upon them, particularly on the north-side, is, in one night's time, wholly converted into ice: they also contain clefts and cavities, where the sun seldom or never injects his rays. Besides these are projections, or landing-places, on the declivities of the steep hills, where the rain and snow-water lodge, and quickly con-

geal. When now the accumulated flakes of snow slide down, or fall with the rain from the eminences above, on these prominences, or, when here and there a mountain-spring comes rolling down to such a lodging-place, where the ice has already seated itself, they all freeze; and add their tribute to it. This, by degrees, waxes to a body of ice, that can no more be overpowered by the sun; and which, though it may indeed, at certain seasons, diminish by a thaw, yet, upon the whole, through annual acquisitions, it assumes an annual growth. Such a body of ice is often prominent far over the rocks. It does not melt on the upper surface, but underneath; and often cracks into many larger or smaller clefts, from whence the thawed water trickles out. By this, it becomes, at last, so weak, that being overloaded with its own ponderous bulk, it breaks loose, and tumbles down the rocks with a terrible crash. Where it happens to overhang a precipice on the shore, it plunges into the deep with a shock like thunder; and with such an agitation of the water, as will overturn a boat at some distance, as many a poor Greenlander has fatally experienced. Thus are these amazing ice mountains launched forth to sea, and found floating in the waters round both the Poles. It is these that have hindered mariners from discovering the extensive countries that lie round the South Pole; and that probably block up the passage to China by the North.

We will conclude this chapter with one effect more, produced by the saltness of the sea; which is, the luminous appearance of its waves in the night. All who have been spectators of a sea by night, a little ruffled with winds, seldom fail of observing its fiery brightness. In some places it shines as far as the eye can reach; at other times, only when the waves boom against the side of the vessel, or the oar dashes into the water. Some seas shine often; others more seldom; some, even when particular winds blow; and others, within a narrow compass; a long tract of light being seen along the surface, whilst all the rest is hid in total darkness. It is not easy to account for these extraordinary appearances: some have supposed that a number of luminous insects produced the effect; and this is in reality sometimes the case; in general, however, they have every resemblance to that light produced by electricity; and, probably, arise from the agitation and dashing of the saline particles of the fluid against each other. But the manner in which this is done, for we can produce nothing similar by any experiments hitherto made, remains for some happier accident to discover. Our progress in the knowledge of nature is slow; and it is a mortifying consideration, that we are hitherto more indebted for success to chance than industry.

## CH A P. XVI.

### Of the Tides, Motion, and Currents of the Sea, with their Effects.

IT was said, in the former chapter, that the waters of the sea were kept sweet by their motion; without which they would soon putrefy, and spread universal infection. If we look for final causes here, indeed, we have a great and an obvious one that presents itself before us. Had the sea been made without motion, and resembling a pool of stagnant water, the nobler races of animated nature would shortly be at an end. Nothing would then be left alive but swarms of ill-formed creatures, with scarce more than vegetable life; and subsisting by putrefaction. Were this extensive bed of waters entirely quiescent, millions of the smaller



smaller reptile kinds would there find a proper resort to breed and multiply in; they would find there no agitation, no concussion in the parts of the fluid to crush their feeble frames, or to force them from the places where they were bred: there they would multiply in security and ease, enjoy a short life, and putrifying, thus again give nourishment to numberless others, as little worthy of existence as themselves. But the motion of this great element effectually destroys the number of these vile creatures: its currents and its tides produce continual agitations, the shock of which they are not able to endure; the parts of the fluid rub against each other, destroy all viscidities; and the ocean, if we may so express it, acquires health by exercise.

The most obvious motion of the sea, and the most generally acknowledged, is that of its tides. This element is observed to flow for certain hours, from south towards the north; in which motion of flux, which lasts about six hours, the sea gradually swells; so that entering the mouths of rivers, it drives back the river waters to their heads. After a continual flux of six hours, the sea seems to rest for a quarter of an hour; and then begins to ebb, or retire back again, from north to south, for six hours more; in which time the waters sinking, the rivers resume their natural course. After a seeming pause of a quarter of an hour, the sea again begins to flow as before: and thus it has alternately risen and fallen, twice a day, since the creation.

This amazing appearance did not fail to excite the curiosity, as it did the wonder of the ancients. After some wild conjectures of the earliest philosophers, it became well known, in the times of Pliny, that the tides were entirely under the influence, in a small degree, of the sun; but in a much greater of the moon. It was found that there was a flux and reflux of the sea, in the space of twelve hours fifty minutes, which is exactly the time of a lunar day. It was observed, that whenever the moon was in the meridian, or, in other words, as nearly as possible over any part of the sea, that the sea flowed to that part, and made a tide there; on the contrary, it was found, that when the moon left the meridian, the sea began to flow back again from whence it came; and there might be said to ebb. Thus far the waters of the sea seemed very regularly to attend the motions of the moon. But as it appeared, likewise, that when the moon was in the opposite meridian, as far off on the other side of the globe, that there was a tide on this side also; so that the moon produced two tides, one by her greatest approach to us, and another by her greatest distance from us: in other words, the moon, in once going round the earth, produced two tides, always at the same time; one on the part of the globe directly under her; and the other on the part of the globe directly opposite.

Mankind continued for several ages content with knowing the general cause of these wonders, hopeless of discovering the particular manner of the moon's operation. Kepler was the first who conjectured that attraction was the principal cause; asserting that the sphere of the moon's operation extended to the earth, and drew up its waters. The precise manner in which this is done, was discovered by Newton.

The moon has been found, like all the rest of the planets, to attract, and to be attracted by the earth. This attraction prevails throughout our whole planetary system. The more matter there is contained in any body, the more it attracts: and its influence decreases in proportion as the distance, when squared, increases. This being premised, let us see what must ensue upon supposing the moon in the meridian of any tract of the sea. The surface of the water immediately under the moon, is nearer

the moon than any other part of the globe is; and, therefore, must be more subject to its attraction than the waters any where else. The waters will, therefore, be attracted by the moon, and rise in an heap; whose eminence will be the highest, where the attraction is greatest. In order to form this eminence, it is obvious that the surface, as well as the depths, will be agitated; and that wherever the water runs from one part, succeeding waters must run to fill up the space it has left. Thus the waters of the sea, running from all parts, to attend the motions of the moon, produce the flowing of the tide; and it is high tide at that part wherever the moon comes over it, or to its meridian.

But when the moon travels onward, and ceases to point over the place where the waters were just risen, the cause here of their rising ceasing to operate, they will flow back by their natural gravity, into the lower parts from whence they had travelled; and this retiring of the waters will form the ebbing of the sea.

Thus the first part of the demonstration is obvious; since, in general, it requires no great sagacity to conceive that the waters nearest the moon are most attracted, or raised highest by the moon. But the other part of the demonstration, namely, how there come to be high tides at the same time, on the opposite side of the globe, and where the waters are farthest from the moon, is not so easy to conceive. To comprehend this, it must be observed, that the part of the earth, and its waters, that are farthest from the moon, are the parts of all others that are least attracted by the moon: it must also be observed, that all the waters, when the moon is on the opposite side of the earth, must be attracted by it in the same direction that the earth itself attracts them; that is, quite through the body of the earth, towards the moon itself. This, therefore, being conceived, it is plain that those waters which are farthest from the moon, will have less weight than those of any other part, on the same side of the globe, because the moon's attraction, which conspires with the earth's attraction, is there least. Now, therefore, the waters farthest from the moon, having less weight, and being lightest, will be pressed on all sides, by those that, having more attraction, are heavier; and the heavier waters flowing in, will make them swell and rise in an eminence directly opposite to that on the other side of the globe, caused by the more immediate influence of the moon.

In this manner the moon, in one diurnal revolution, produces two tides; one raised immediately under the sphere of its influence, and the other directly opposite to it. As the moon travels, this vast body of waters rears upward, as if to watch its motions; and pursues the same constant rotation. However, in this great work of raising the tides, the sun has no small share; it produces its own tides constantly every day, just as the moon does, but in a much less degree, because the sun is at an immensely greater distance. Thus there are solar tides, and lunar tides. When the forces of these two great luminaries concur, which they always do when they are either in the same, or in opposite parts of the heavens, they jointly produce a much greater tide, than when they are so situated in the heavens, as each to make peculiar tides of their own. To express the very same thing technically; in the conjunctions and oppositions of the sun and moon, the attraction of the sun conspires with the attraction of the moon; by which means the high spring-tides are formed. But in the quadratures of the sun and moon, the water raised by the one is depressed by the other; and hence the lower neap-tides have their production. In a word, the tides are greatest in the syzygies, and least in the quadratures.



This theory well understood, and the astronomical terms previously known, it may readily be brought to explain the various appearances of the tides, if the earth were covered with a deep sea, and the waters uninfluenced by shoals, currents, straits, or tempests. But in every part of the sea, near the shores, the geographer must come in to correct the calculations of the astronomer. For, by reason of the shallowness of some places, and the narrowness of the straits in others, there arises a great diversity in the effect, not to be accounted for without an exact knowledge of all the circumstances of the place. In the great depths of the ocean, for instance, a very slow and imperceptible motion of the whole body of water will suffice to raise its surface several feet high; but if the same increase of water is to be conveyed through a narrow channel, it must rush through it with the most impetuous rapidity. Thus, in the English channel, and the German ocean, the tide is found to flow strongest in those places that are narrowest; the same quantity of water being, in this case, driven through a smaller passage. It is often seen, therefore, pouring through a strait with great force; and, by its rapidity, considerably raised above the surface of that part of the ocean into which it runs.

This shallowness and narrowness in many parts of the sea, give also rise to a peculiarity in the tides of some parts of the world. For in many places, and in our own seas in particular, the greatest swell of the tide is not while the moon is in its meridian height, and directly over the place, but some time after it has declined from thence. The sea, in this case, being obstructed, pursues the moon with what dispatch it can, but does not arrive with all its waters till long after the moon has ceased to operate. Lastly, from this shallowness of the sea, and from its being obstructed by shoals and straits, we may account for the Mediterranean, the Baltic, and the Black Sea, having no sensible tides. These, though to us they seem very extensive, are not however large enough to be affected by the influence of the moon; and as to their communication with the ocean, through such narrow inlets, it is impossible in a few hours they should receive and return water enough to raise or depress them in any considerable degree.

In general we may observe, that all tides are much higher, and more considerable in the torrid zone, than in the rest of the ocean; the sea in those parts being generally deeper, and less affected by changeable winds, or winding shores. The greatest tide we know of, is that at the mouth of the river Indus, where the water rises thirty feet in height. How great, therefore, must have been the amazement of Alexander's soldiers at so strange an appearance! They who always before had been accustomed only to the scarcely perceptible risings of the Mediterranean, or the minute intumescence of the Black Sea, when made at once spectators of a river rising and falling thirty feet in a few hours, must no doubt have felt the most extreme awe, and (as Quintus Curtius tells us) a mixture of curiosity and apprehension. The tides are also remarkably high on the coasts of Malay, in the straits of Sunda, in the Red Sea, at the mouth of the river St. Lawrence, along the coasts of China and Japan, at Panama, and in the gulph of Bengal. The tides at Tonquin, however, are the most remarkable in the world. In this part there is but one tide, and one ebb, in twenty-four hours; whereas, as we have said before, in other places there are two. Besides, there, twice in each month there is no tide at all, when the moon is near the equinoctial, the water being for some time quite stagnant. These, with some other odd appearances attending the same pheno-

mena, were considered by many as marvellous; but Sir Isaac Newton, with peculiar sagacity, judged them to arise from the concurrence of two tides, one from the South Sea, and the other from the Indian Ocean. Of each of these tides there come successively two every day; two at one time greater, and two at another that are less. The time between the arrival of the two greater, is considered by him as high tide; the time between the two lesser, as ebb. In short, with this clue, that great mathematician solved every appearance, and he established his theory as to silence every opposer.

This fluctuation of the sea from the tides, produces another, and more constant rotation of its waters, from the east to the west, in this respect following the course of the moon. This may be considered as one great and general current of the waters of the sea; and although it be not every where distinguishable, it is nevertheless every where existent, except when opposed by some particular current or eddy, produced by partial and local causes. This tendency of the sea towards the west is plainly perceivable in all the great straits of the ocean; as, for instance, in those of Magellan, where the tide running in from the east, rises twenty feet high, and continues flowing six hours; whereas the ebb continues but two hours, and the current is directed to the west. This proves that the flux is not equal to the reflux, and that from both results a motion of the sea westward, which is more powerful during the time of the flux than the reflux.

But this motion westward has been sensibly observed by navigators, in their passage back from India to Madagascar, and so on to Africa. In the great Pacific Ocean also it is very perceivable; but the places where it is most obvious are, as was said, in those straits which join one ocean to another. In the straits between the Maldivia islands, in the gulph of Mexico, between Cuba and Yucatan. In the straits of the gulph of Paria, the motion is so violent, that it hath received the appellation of the Dragon's Mouth. Northward, in the sea of Canada, in Waigat's straits, in the straits of Java, and, in short, in every strait where the ocean on one part pours into the ocean on the other. In this manner, therefore, is the sea carried with an unceasing circulation round the globe; and, at the same time, that its waters are pushed back and forward with the tide, they have thus a progressive current to the west, which, though less observable, is not the less real.

Besides these two general motions of the sea, there are others which are particular to many parts of it, and are called currents. These are found to run in all directions, east, west, north, and south; being formed, as was said above, by various causes; the prominence of the shores, the narrowness of the straits, the variations of the wind, and the inequalities at the bottom. These, though no great object to the philosopher, as their causes are generally local and obvious, are nevertheless of the most material consequence to the mariner; and, without a knowledge of which, he could never succeed. It often has happened, that when a ship has unknowingly got into one of these, every thing seems to go forward with success, the mariners suppose themselves every hour approaching their wish'd-for port, the wind fills their sails, and the ship's prow seems to divide the water; but, at last, by miserable experience they find, that instead of going forward, they have been all the time receding. The bust of currents, therefore, makes a considerable article in navigation; and the direction of their stream, and their rapidity, has been carefully set down. This some do by the observation of the surface of the current; or by the driving of the froth along the shore; or by throwing out what is called the



log-line, with a buoy made for that purpose; and by the direction and motion of this, they judge of the setting; and the rapidity of the current. These currents are generally found to be most violent under the equator, where indeed all the motions of the ocean are most perceivable. Along the coasts of Guinea, if a ship happens to overshoot the mouth of any river it is bound to, the current prevents its return; so that it is obliged to steer out to sea, and take a very large compass, in order to correct the former mistake. These set in a contrary direction to the general motion of the sea westward; and that so strongly, that a passage which with the current is made in two days, is with difficulty performed in six weeks against it. However, they do not extend above twenty leagues from the coast; and ships going to the East-Indies, take care not to come within the sphere of their action. At Sumatra, the currents, which are extremely rapid, run from south to north: there are also strong currents between Madagascar and the Cape of Good Hope. On the western coasts of America, the current always runs from the south to the north, where a south wind, continually blowing, most probably occasions this phenomenon. But the currents that are most remarkable, are those continually flowing into the Mediterranean sea, both from the ocean by the streights of Gibraltar, and at its other extremity, from the Euxine sea by the Archipelago. This is one of the most extraordinary appearances in nature, this large sea receiving not only the numerous rivers that fall into it, such as the Nile, the Rhone, and the Po, but also a very great influx from the Euxine sea on one part, and the ocean on the other. At the same time, it is seen to return none of those waters it is thus known to receive: outlets running from it there are none; no rivers but such as bring it fresh supplies; no streights but what are constantly pouring their waters into it. It has therefore been the wonder of mankind in every age, how and by what means this vast concourse of waters are disposed of; or how this sea, which is always receiving, and never returning, is no way fuller than before. In order to account for this, some have said, that the water was re-conveyed, by subterraneous passages into the Red Sea. There is a story told of an Arabian caiff, who caught a dolphin in this sea, admiring the beauty of which, he let it go again, having previously marked it by a ring of iron. Some time after a dolphin was caught in the Red Sea, and quickly known by the ring to be the same that had been taken in the Mediterranean before. Such, however, as have not been willing to found their opinions upon a story, have attempted to account for the disposal of the waters of the Mediterranean by evaporation. For this purpose they have entered into long calculations upon the extent of its surface, and the quantity of water that would be raised from such a surface in a year. They then compute how much water runs in by its rivers and streights in that time; and find, that the quantity exhausted by evaporation greatly exceeds the quantity supplied by rivers and seas. This solution, no doubt, would be satisfactory, did not the ocean, and the Euxine, evaporate as well as the Mediterranean: and as these are subject to the same drain, it must follow, that all the seas will in this respect be upon a par; and, therefore, there must be some other cause for this unperceived drain, and continual supply. This seems to be satisfactorily enough accounted for by Doctor Smith, who supposes an under current running through the streights of Gibraltar to carry out as much water into the ocean, as the upper current continually carries in from it. To confirm this, he observes, that nearer home, between the north and south Foreland, the tide is

known to run one way at top, and the ebb another way at bottom. This double current he also confirms by an experiment communicated to him by an able seaman, who being with one of the king's frigates in the Baltic, found he went with his boat into the mid-stream, and was carried violently by the current; upon which a basket was sunk, with a large cannon-ball, to a certain depth of water, which gave a check to the boat's motion; as the basket sunk still lower, the boat was driven, by the force of the water below, against the upper current; and the lower the basket was let down, the stronger the under current was found, and the quicker was the boat's motion against the upper stream, which seemed not to be above four fathom deep. From hence we may readily infer, that the same cause may operate at the streights of Gibraltar; and that while the Mediterranean seems replenishing at top, it may be emptying at bottom. The number of the currents at sea are impossible to be recounted; nor indeed are they always known; new ones are daily produced by a variety of causes, and as quickly disappear. When a regular current is opposed by another in a narrow freight, or where the bottom of the sea is very uneven, a whirlpool is often formed. These were formerly considered as the most formidable obstructions to navigation, and the ancient poets and historians speak of them with terror; they are described as swallowing up ships, and dashing them against the rocks at the bottom: apprehension did not fail to add imaginary terrors to the description, and placed at the center of the whirlpool a dreadful den, fraught with monsters whose howlings served to add new horrors to the dashings of the deep. Mankind at present, however, view these eddies of the sea with very little apprehension; and some have wondered how the ancients could have so much overcharged their descriptions. But all this is very naturally accounted for. In those times when navigation was in its infancy, and the slightest concussion of the waves generally sent the poor adventurer to the bottom, it is not to be wondered at that he was terrified at the violent agitations in one of these. When his little ship, but ill fitted for opposing the fury of the sea, was got within the vortex, there was then no possibility of ever returning. To add to the fatality, they were always near the shore; and along the shore was the only place where this ill provided mariner durst venture to sail. These were, therefore, dreadful impediments to his navigation; for if he attempted to pass between them and the shore, he was sometimes sucked in by the eddy; and if he attempted to avoid them out at sea, he was often sunk by the storm. But in our time, and in our present improved state of navigation, Charybdis, and the Eurypus, with all the other irregular currents of the Mediterranean, are no longer formidable. Mr. Addison, not attending to this train of thinking, upon passing through the streights of Sicily, was surprised at the little there was of terror in the present appearance of Sylla and Charybdis; and seems to be of opinion, that their agitations are much diminished since the times of antiquity. In fact, from the reasons above, all the wonders of the Mediterranean sea are described in much higher colours than they merit, to us who are acquainted with the more magnificent terrors of the ocean. The Mediterranean is one of the smoothest and most gentle seas in the world; its tides are scarce perceivable, except in the gulph of Venice, and shipwrecks are less known there than in any other part of the world. It is in the ocean, therefore, that these whirlpools are particularly dangerous, where the tides are violent, and the tempests fierce. To mention only



only one, that called the Maelstrom upon the coasts of Norway, which is considered as the most dreadful and voracious in the world. The name it has received from the natives, signifies the navel of the sea, since they suppose that a great share of the water of the sea is sucked up and discharged by its vortex. A minute description of the internal parts is not to be expected, since none who were there ever returned to bring back information. The body of the waters that form this whirlpool, are extended in a circle above thirteen miles in circumference. In the midst of this stands a rock, against which the tide in its ebb is dashed with inconceivable fury. At this time it instantly swallows up all things that come within the sphere of its violence, trees, timber, and shipping. No skill in the mariner, nor strength of rowing, can work an escape: the sailor at the helm finds the ship at first go in a current opposite to his intentions: his vessel's motion, though slow in the beginning, becomes every moment more rapid; it grows round in circles still narrower and narrower, till at last it is dashed against the rocks, and instantly disappears: nor is it seen again for six hours: till the tide flowing, it is vomited forth with the same violence with which it was drawn in. The noise of this dreadful vortex still farther contributes to increase its terror, which with the dashing of the waters, and the dreadful valley, if it may be so called, caused by their circulation, makes one of the most tremendous objects in nature.

## C H A P. XVII.

Of the Changes produced by the Sea upon the Earth.

**F**ROM what has been said, as well of the earth, as of the sea, they both appear to be in continual fluctuation. The earth, the common promontory that supplies subsistence to men, animals, and vegetables, is continually furnishing its stores to their support. But the matter which is thus derived from it, is soon restored and laid down again to be prepared for fresh mutations. The transmigration of souls is no doubt false and whimsical; but nothing can be more certain than the transmigration of bodies: the spoils of the meanest reptile may go to the formation of a prince, and, on the contrary, as the poet has it, the body of Cæsar may be employed in stopping a beer-barrel. From this, and other causes, therefore, the earth is in continual change. Its internal fires, the deviation of its rivers, and the falling of its mountains, are daily altering its surface; and geography can scarce recollect the lakes and the valleys that history once described.

But these changes are nothing to the instability of the ocean. It would seem that inquietude was as natural to it as its fluidity. It is first seen with a constant and equable motion going towards the west; the tides then interrupt this progression, and for a time drive the waters in a contrary direction; beside these agitations, the currents act their part in a smaller sphere, being generally greatest where the other motions of the sea are least; namely, nearest the shore: the winds also contribute their share in this universal fluctuation, so that scarce any part of the sea is wholly seen to stagnate.

As this great element is thus changed, and continually labouring internally, it may be readily supposed that it produces correspondent changes upon its shores, and those parts of the earth subject to

its influence. In fact, it is every day making considerable alterations, either by overflowing its shores in one place, or deserting them in others; by covering over whole tracts of country, that were cultivated and peopled, at one time; or by leaving its bed to be appropriated to the purposes of vegetation, and to supply a new theatre for human industry at another.

In this struggle between the earth and the sea for dominion, the greatest number of our shores seem to defy the whole rage of the waves, both by their height, and the rocky materials of which they are composed. The coasts of Italy, for instance, are bordered with rocks of marble of different kinds, the quarries of which may easily be distinguished at a distance from sea, and appear like perpendicular columns, of the most beautiful kinds of marble, ranged along the shore. In general, the coasts of France, from Brest to Bourdeaux, are composed of rocks; as are also those of Spain and England, which defend the land, and only are interrupted, here and there, to give an egress to rivers, and to grant the conveniences of bays and harbours to our shipping. It may be in general remarked, that wherever the sea is most violent and furious, there the boldest shores, and of the most compact materials, are found to oppose it. There are many shores several hundred feet perpendicular, against which the sea, when swollen with tides or storms, rises and beats with inconceivable fury. In the Orkneys, where the shores are thus formed, it sometimes, when agitated by a storm, rises two hundred feet perpendicular, and dashes up its spray, together with sand, and other substances, that compose its bottom, upon land, like showers of rain.

From hence, therefore, we may conceive how the violence of the sea, and the boldness of the shore, may be said to have made each other. Where the sea meets no obstacles, it spreads its waters with a gentle intumescence, till all its power is destroyed, by wanting depth to aid the motion. But when its progress is checked in the midst, by the prominence of rocks, or the abrupt elevation of the land, it dashes with all the force of its depth against the obstacle, and forms, by its repeated violence, that abruptness of the shore which confines its impetuosity. Where the sea is extremely deep, or very much vexed by tempests, it is no small obstacle that can confine its rage; and for this reason we see the boldest shores projected against the deepest waters; all less impediments having long before been surmounted and washed away. Perhaps of all the shores in the world, there is not one so high as that on the west of St. Kilda, which, upon a late admeasurement, was found to be six hundred fathom perpendicular above the surface of the sea. Here also, the sea is deep, turbulent, and stormy; so that it requires great force in the shore to oppose its violence. In many parts of the world, and particularly upon the coasts of the East-Indies, the shores, though not high above water, are generally very deep, and consequently the waves roll against the land with great weight and irregularity. This rising of the waves against the shore, is called by mariners the surf of the sea; and in shipwrecks is generally fatal to such as attempt to swim on shore. In this case, no dexterity in the swimmer, no float he can use, neither swimming girdle nor cork jacket will save him; the weight of the superincumbent waves break upon him at once, and crushes him with certain ruin. Some few of the natives, however, have the art of swimming and of navigating their little boats near those shores, where an European is sure of instant destruction.



In places where the force of the sea is less violent, or its tides less rapid, the shores are generally seen to descend with a more gradual declivity. Over these, the waters of the tide steal by almost imperceptible degrees, covering them for a large extent, and leaving them bare on its recess. Upon these shores, as was said, the sea seldom beats with any great violence, as a large wave has not depth sufficient to float it onwards; so that here only are to be seen gentle surges making calmly towards land, and lessening as they approach. As the sea, in the former description, is generally seen to present prospects of tumult and uproar, here it more usually exhibits a scene of repose and tranquil beauty. Its waters, which when surveyed from the precipice, afforded a muddy greenish hue, arising from their depth and position to the eye, when regarded from a shelving shore, wear the colour of the sky, and seem rising to meet it. The deafening noise of the deep sea, is here converted into gentle murmurs; instead of the water's dashing against the face of the rock, it advances and recedes, still going forward, but with just force enough to push its weeds and shells, by insensible approaches, to the shore.

There are other shores, beside those already described, which either have been raised by art to oppose the sea's approaches, or from the sea's gaining ground, are threatened with imminent destruction. The sea's being thus seen to give and take away lands at pleasure, is, without question, one of the most extraordinary considerations in all natural history. In some places it is seen to obtain the superiority by slow and certain approaches; or to burst in at once, and overwhelm all things in undistinguished destruction; in other places it departs from its shores, and where its waters have been known to rage, it leaves fields covered with the most beautiful verdure.

The formation of new lands, by the sea's continually bringing its sediment to one place, and by the accumulation of its sands in another, is easily conceived. We have had many instances of this in England. The island of Oxney, which is adjacent to Romney-marsh, was produced in this manner. This had for a long time been a low level, continually in danger of being overflowed by the river Rother; but the sea, by its depositions, has gradually raised the bottom of the river, while it has hollowed the mouth; so that the one is sufficiently secured from inundations, and the other is deep enough to admit ships of considerable burthen. The like also may be seen at that bank called the Dogger-sands, where two tides meet, and which thus receive new increase every day, so that in time the place seems to promise fair for being habitable earth. On many parts of the coasts of France, England, Holland, Germany, and Prussia, the sea has been sensibly known to retire. Hubert Thomas asserts, in his Description of the Country of Liege, that the sea formerly encompassed the city of Tongres, which, however, is at present thirty-five leagues distant from it: this assertion he supports by many strong reasons; and among others, by the iron rings fixed in the walls of the town, for fastening the ships that came into the port. In Italy there is a considerable piece of ground gained at the mouth of the river Arno; and Ravenna, that once stood by the sea-side, is now considerably removed from it. But we need scarce mention these, when we find that the whole republic of Holland seems to be a conquest upon the sea, and in a manner rescued from its bosom. The surface of the earth, in this country, is below the level of the bed of the sea; and we remember, upon approaching the coast, to have looked down

upon it from the sea, as into a valley; however, it is every day rising higher by the depositions made upon it by the sea, the Rhine, and the Meuse; and those parts which formerly admitted large men of war, are now known to be too shallow to receive ships of very moderate burthen. The province of Jucatan, a peninsula in the gulph of Mexico, was formerly a part of the sea: this tract, which stretches out into the ocean an hundred leagues, and which is above thirty broad, is every where, at a moderate depth below the surface, composed of shells, which evince that its land once formed the bed of the sea. In France, the town of Aigues Mortes was a port in the times of St. Louis, which is now removed more than four miles from the sea. Psalmodi, in the same kingdom, was an island in the year 815, but is now more than six miles from the shore. All along the coast of Norfolk, we are well assured, that in the memory of man, the sea has gained fifty yards in some places, and has lost as much in others.

Thus numerous, therefore, are the instances of new lands having been produced from the sea, which, as we see, is brought about two different ways: first, by the waters raising banks of sand and mud where their sediment is deposited; and secondly, by their relinquishing the shore entirely, and leaving it unoccupied to the industry of man.

But as the sea has been thus known to recede from some lands, so has it, by fatal experience, been found to encroach upon others: and, probably, these depredations on one part of the shore, may account for their dereliction from another; for the current which rested upon some certain bank, having got an egress in some other place, it no longer presses upon its former bed, but pours all its stream into the new entrance, so that every inundation of the sea may be attended with some correspondent dereliction of another shore.

However this be, we have numerous histories of the sea's inundations, and its burying whole provinces in its bosom. Many countries that have been thus destroyed, bear melancholy witness to the truth of history; and shew the tops of their houses, and the spires of their steeples, still standing at the bottom of the water. One of the most considerable inundations we have in history, is that which happened in the reign of Henry I. which overflowed the estates of the Earl Godwin, and forms now that bank called the Goodwin sands. In the year 1546, a similar irruption of the sea destroyed an hundred thousand persons in the territory of Dort; and yet a greater number round Dullart. In Friezland, and Zealand, there were more than three hundred villages overwhelmed; and their remains continue still visible at the bottom of the water in a clear day. The Baltic sea has, by slow degrees, covered a large part of Pomerania; and, among others, destroyed and overwhelmed the famous port of Vineta. In the same manner, the Norwegian sea has formed several little islands from the main land, and still daily advances upon the continent. The German sea has advanced upon the shores of Holland, near Catt; so that the ruins of an ancient citadel of the Romans, which was formerly built upon this coast, are now actually under water. To these accidents several more might be added; our own historians, and those of other countries, abound with them; almost every flat shore of any extent, being able to shew something that it has lost, or something that it has gained from the sea.

There are some shores on which the sea has made temporary depredations; where it has overflowed, and after remaining perhaps some ages it has again retired of its own accord, or been driven back



back by the industry of man. There are many lands in Norway, Scotland, and the Maldivia islands, that are at one time covered with water, and at another free. The country round the Isle of Ely, in the times of Bede, about a thousand years ago, was one of the most delightful spots in the whole kingdom. It was not only richly cultivated, and produced all the necessaries of life, but grapes also that afforded excellent wine. The accounts of that time are copious in the description of its verdure and fertility; its rich pastures, covered with flowers and herbage; its beautiful shades; and wholesome air. But the sea breaking in, upon the land, overwhelmed the whole country, took possession of the soil, and totally destroyed one of the most fertile vallies in the world. Its air, from being dry and healthful, from that time became most unwholesome, and clogged with vapours; and the small part of the country that, by being higher than the rest, escaped the deluge, was soon rendered uninhabitable, from its noxious vapours. Thus this country continued under water for some centuries; till, at last, the sea, by the same caprice which had prompted its invasions, began to abandon the earth in like manner. It has continued for some ages to relinquish its former conquests; and although the inhabitants can neither boast the longevity, nor the luxuries of their former pre-occupants, yet they find ample means of subsistence; and if they happen to survive the first year of their residence there, they are often known to arrive at a good old age.

But although history be silent as to many other inundations of the like kind, where the sea has overflowed the country, and afterwards retired, yet we have numberless testimonies of another nature, that prove it beyond the possibility of doubt: we mean those numerous trees that are found buried at considerable depths in places where either rivers, or the sea, has accidentally overflowed. At the mouth of the river Nefs, near Bruges, in Flanders, at the depth of fifty feet, are found great quantities of trees lying as close to each other as they do in a wood: the trunks, the branches, and the leaves, are in such perfect preservation, that the particular kind of each tree may instantly be known. About five hundred years ago, this very ground was known to have been covered with the sea; nor is there any history or tradition of its having been dry ground, which we can have no doubt must have been the case. Thus we see a country flourishing in verdure, producing large forests, and trees of various kinds, overwhelmed by the sea. We see this element depositing its sediment to an height of fifty feet; and its waters must, therefore, have risen much higher. We see the same, after it has thus overwhelmed, and sunk the land so deep beneath its slime, capriciously retiring from the same coasts, and leaving that habitable once more, which it had formerly destroyed. All this is wonderful; and perhaps, instead of attempting to enquire after the cause, which has hitherto been inscrutable, it will best become us to rest satisfied with admiration.

At the city of Modena in Italy, and about four miles round it, wherever it is dug, when the workmen arrive at the depth of sixty-three feet, they come to a bed of chalk, which they bore with an augre five feet deep: they then withdraw from the pit, before the augre is removed, and upon its extraction, the water bursts up through the aperture with great violence, and quickly fills this new-made well, which continues full, and is affected neither by rains or droughts. But that which is most remarkable in this operation, is the layers of earth as we descend. At the depth of fourteen feet, are found the ruins of an ancient city, paved streets, houses, floors, and different pieces of Mo-

saic. Under this is found a solid earth, that would induce one to think had never been removed; however, under it is found a soft oozy earth, made up of vegetables; and at twenty-six feet depth, large trees entire, such as walnut-trees, with the walnuts still sticking on the stem, and their leaves and branches in exact preservation. At twenty-eight feet deep, a soft chalk is found, mixed with a vast quantity of shells; and this bed is eleven feet thick. Under this, vegetables are found again, with leaves, and branches of trees as before; and thus alternately chalk and vegetable earth to the depth of sixty-three feet. These are the layers where the workmen attempt to bore; while in many of them, they also find pieces of charcoal, bones, and bits of iron. From this description, therefore, it appears, that this country has been alternately overflowed and deserted by the sea, one age after another: nor were these overflowings and retirings of trifling depth, or of short continuance. When the sea burst in, it must have been a long time in overwhelming the branches of the fallen forest with its sediments; and still longer in forming a regular bed of shells eleven feet over them. It must have, therefore, taken an age, at least, to make any one of these layers; and we may conclude, that it must have been many ages employed in the production of them all. The land, also, upon being deserted, must have had time to grow compact, to gather fresh fertility, and to be drained of its waters before it could be disposed to vegetation; or before its trees could have shot forth again to maturity.

We have instances nearer home of the same kind, given us in the Philosophical Transactions; one of them by Mr. Derham. An inundation of the sea, at Dagenham, in Essex, laying bare a part of the adjacent pasture, for above two hundred feet wide, and, in some places, twenty deep, it discovered a number of trees that had lain there for many ages before; these trees, by lying long under ground, were become black and hard, and their fibres so tough, that one might as easily break a wire, as any of them: they lay so thick in the place where they were found, that in many parts he could step from one to another: he conceived also, that not only all the adjacent marshes, for several hundred acres, were covered underneath with such timber, but also the marshes along the mouth of the Thames, for several miles. The meeting with these trees at such depths, he ascribes to the sediment of the river, and the tides, which constantly washing over them, have always left some part of their substance behind, so as, by repeated alluvions, to work a bed of vegetable earth over them, to the height at which he found it.

The levels of Hatfield-Chace, in Yorkshire, a tract of above eighteen thousand acres, which was yearly overflowed, was reduced to arable and pasture land, by one Sir Cornelius Vermusden, a Dutchman. At the bottom of this wide extent, are found millions of the roots and bodies of trees, of such as this island either formerly did, or does at present produce. The roots of all stand in their proper postures; and by them, as thick as ever they could grow, the respective trunks of each, some above thirty-yards long. The oaks, some of which have been sold for fifteen pounds a piece, are as black as ebony, very lasting, and close grained. The ash-trees are as soft as earth, and are commonly cut in pieces by the workmen's spades, and as soon as flung up into the open air, turn to dust. But all the rest, even the willows themselves, which are softer than the ash, preserve their substance and texture to this very day. Some of the firs appear to have vegetated, even after they were fallen, and to have, from their branches, struck up large trees, as great as the parent trunk. It is observable, that many



many of these trees have been burnt, some quite through, some on one side, some have been found chopped and squared, others riven with great wooden wedges, all sufficiently manifesting, that the country, which was deluged, had formerly been inhabited. Near a great root of one tree, were found eight coins of the Roman emperors; and, in some places, the marks of the ridge and furrow were plainly perceivable, which testified that the ground had formerly been patient of cultivation.

The learned naturalist who has given this description, has pretty plainly evinced, that this forest, in particular, must have been thus levelled by the Romans; and that the falling of the trees, must have contributed to the accumulation of the waters. "The Romans," says he, "when the Britons fled, always pursued them into the fortresses of low woods, and miry forests: in these the wild natives found shelter; and, when opportunity offered, issued out, and fell upon their invaders without mercy. In this manner, the Romans were at length so harraressed, that orders were issued out for cutting down all the woods and forests in Britain. In order to effect this, and destroy the enemy the easier, they set fire to the woods, composed of pines, and other inflammable timber, which spreading, the conflagration destroyed not only the forest, but infinite numbers of the wretched inhabitants who had taken shelter therein. When the pine-trees had thus done what mischief they could, the Romans then brought their army nearer, and, with whole legions of the captive Britons, cut down most of the trees that were yet left standing; leaving only here and there some great trees untouched, as monuments of their fury. These, unneedful of their labour, being destitute of the support of the underwood, and of their neighbouring trees, were easily overthrown by the winds, and, without interruption, remained on the places where they happened to fall. The forest, thus fallen, must necessarily have stopped up the currents, both from land and sea; and turned into great lakes, what were before but temporary streams. The working of the waters here, the consumption and decay of rotten boughs and branches, and the vast increase of water-moss which flourishes upon marshy grounds, soon formed a covering over the trunks of the fallen trees, and raised the earth several feet above its former level. The earth thus every day swelling, by a continual increase from the sediment of the waters, and by the lightness of the vegetable substances of which it was composed, soon overtopped the waters by which this intumescence was at first effected; so that it entirely got rid of its inundations, or only demanded a slight assistance from man for that purpose." This may be the origin of all bogs, which are formed by the putrefaction of vegetable substances, mixed with the mud and slime deposited by waters, and at length acquiring a sufficient consistency.

From this we see what powerful effects the sea is capable of producing upon its shores, either by overflowing some, or deserting others; by altering the direction of these, and rendering those craggy and precipitate, which before were shelving. But the influence it has upon these, is nothing to that which it has upon that great body of earth which forms its bottom. It is at the bottom of the sea that the greatest wonders are performed, and the most rapid changes are produced; it is there that the motion of the tides and the currents have their whole force, and agitate the substances of which their bed is composed. But all these are almost wholly hid from human curiosity: the miracles of the deep are performed in secret; and we have but little information from its abysses, except what we receive by inspection at very shallow depths, or by the

plummet, or from divers, who are known to descend from twenty to thirty fathom.

The eye can reach but a very short way into the depths of the sea; and that only, when its surface is glassy and serene. In many seas it perceives nothing but a bright sandy plain at bottom, extending for several hundred miles, without an intervening object. But in others, particularly in the Red Sea, it is very different: the whole bottom of this extensive bed of waters is, literally speaking, a forest of submarine plants, and corals formed by insects for their habitation, sometimes branching out to a great extent. Here are seen the madrepores, the sponges, mosses, sea-mushrooms, and other marine productions, covering every part of the bottom; so that some have even supposed the sea to have taken its name from the colour of its plants below. However, these plants are by no means peculiar to this sea, as they are found in great quantities in the Persian gulph, along the coasts of Africa, and those of Provence and Catalonia.

The bottom of many parts of the sea near America presents a very different, though a very beautiful appearance. This is covered with vegetables, which make it look as green as a meadow, and beneath are seen thousands of turtles, and other sea-animals, feeding thereon.

In order to extend our knowledge of the sea to greater depths, recourse has been had to the plummet; which is generally made of a lump of lead of about forty pounds weight, fastened to a cord. This, however, only answers in moderate depths; for when a deep sea is to be sounded, the matter of which the cord is composed being lighter than the water, floats upon it, and when let down to a considerable depth, its length so increases its surface, that it is often sufficient to prevent the lead from sinking; so that this may be the reason that some parts of the sea are said to have no bottom.

In general, we learn from the plummet, that the bottom of the sea is tolerably even where it has been examined; and that the farther from the shore, the sea is in general the deeper. Notwithstanding in the midst of a great and unfathomable ocean, we often find an island raising its head, and singly braving its fury. Such islands may be considered as the mountains of the deep; and, could we for a moment imagine the waters of the ocean removed, or dried away, we should probably find the inequalities of its bed resembling those that are found at land. Here extensive plains; there valleys; and, in many places, mountains of amazing height. M. Buache has actually given us a map of that part of its bottom, which lies between Africa and America, taken from the several soundings of mariners: in it we find the same uneven surface that we do upon land, the same eminences, and the same depressions. In such an imaginary prospect, however, there would be this difference, that, at the tops of land-mountains appear the most barren and rocky, the tops of sea-mountains would be found the most verdant and fruitful.

The plummet, which thus gives us some idea of the inequalities of the bottom, leaves us totally in the dark as to every other particular; recourse, therefore, has been had to divers: these, either being bred up in this dangerous way of life, and accustomed to remain some time under water without breathing, or assisted by means of a diving-bell, have been able to return some confused and uncertain accounts of the places below. In the great diving-bell improved by Doctor Halley, which was large enough to contain five men, and was supplied by fresh air by buckets, that alternately rose and fell, they descended fifty fathom. In this huge machine, which was let down from the mast of the ship, the doctor himself went down to the



the bottom, where, when the sea was clear, and especially when the sun shone, he could see perfectly well to write or read, and much more to take up any thing that was underneath: at other times, when the water was troubled and thick, it was as dark as night below, so that he was obliged to keep a candle lighted at the bottom. But there is one thing very remarkable: that the water which from above was usually seen of a green colour, when looked at from below, appeared to him of a very different one, casting a redness upon one of his hands, like that of damask roses: a proof of the sea's taking its colour not from any thing floating in it, but from the different reflections of the rays of light. Upon the whole, the accounts we have received from the bottom, by this contrivance, are but few. We learn from it, and from divers in general, that while the surface of the sea may be deformed by tempests, it is usually calm and temperate below; that some divers who have gone down when the weather was calm, and came up when it was tempestuous, were surprised at their not perceiving the change at the bottom. This, however, must not be supposed to obtain with regard to the tides, and the currents, as they are seen constantly shifting their bottom; taking their bed with great violence from one place, and depositing it upon another. We are informed, also, by divers, that the sea grows colder in proportion as they descend to the bottom; that as far as the sun's rays pierce, it is influenced by their warmth; but lower, the cold becomes almost intolerable. A person of quality, who had been himself a diver, as Mr. Boyle informs us, declared, that though he seldom descended above three or four fathoms, yet he found it so much colder than near the top, that he could not well endure it; and that being let down in a great diving-bell, although the water could not immediately touch him, he found the air extremely cold upon his first arrival at the bottom.

From divers also we learn, that the sea in many places is filled with rocks at bottom: and that among their cliffs, and upon their sides, various substances sprout forward, which are either really vegetables, or the nests of insects, increased to some magnitude. Some of these assume the shape of beautiful flowers; and, though soft, when taken up, soon harden, and are kept in the cabinets of the curious.

But, of all those divers who have brought us information from the bottom of the deep, the famous Nicola Pesce, whose performances are told us by Kircher, is the most celebrated. We will not pretend to vouch for the veracity of Kircher's account, which he assures us he had from the archives of the kings of Sicily; but it may serve to enliven an heavy chapter. "In the times of Frederic, king of Sicily, there lived a celebrated diver, whose name was Nicolas, and who from his amazing skill in swimming, and his perseverance under water, was surnamed the fish. This man had, from his infancy, been used to the sea; and earned his scanty subsistence by diving for corals and oysters, which he sold to the villagers on shore. His long acquaintance with the sea, at last, brought it to be almost his natural element. He frequently was known to spend five days in the midst of the waves, without any other provisions than the fish which he caught there, and ate raw. He often swam over from Sicily to Calabria, a tempestuous and dangerous passage, carrying letters from the king. He was frequently known to swim among the gulphs of the Lipari Islands, no way apprehensive of danger.

"Some mariners out at sea one day observed something at some distance from them, which they regarded as a sea-monster; but upon its approach,

it was known to be Nicolas; whom they took into their ships. When they asked him whither he was going in so stormy and rough a sea, and at such a distance from land, he shewed them a packet of letters, which he was carrying to one of the towns of Italy, exactly done up in a leather bag, in such a manner as that they could not be wetted by the sea. He kept them thus company for some time on their voyage, conversing and asking questions; and after eating an hearty meal with them, he took his leave, and jumping into the sea, pursued his voyage alone.

"In order to aid these powers of enduring in the deep, nature seemed to have assisted him in a very extraordinary manner; for the spaces between his fingers and toes were webbed, as in a goose; and his chest became so very capacious, that he could take in at one inspiration, as much breath as would serve him for a whole day.

"The account of so extraordinary a person did not fail to reach the king himself; who actuated by the general curiosity, ordered that Nicolas should be brought before him. It was no easy matter to find Nicolas, who generally spent his time in the solitudes of the deep; but at last, however, after much searching, he was found, and brought before his majesty. The curiosity of this monarch had been long excited by the accounts he had heard of the bottom of the gulph of Charybdis; he therefore conceived that it would be a proper opportunity to have more certain information; and commanded our poor diver to examine the bottom of this dreadful whirlpool: as an incitement to his obedience, he ordered a golden cup to be flung into it. Nicolas was not insensible of the danger to which he was exposed; dangers best known only to himself; and he therefore presumed to remonstrate; but the hopes of the reward, the desire of pleasing the king, and the pleasure of shewing his skill, at last prevailed. He instantly jumped into the gulph, and was swallowed as instantly up in its bosom. He continued for three quarters of an hour below; during which time the king and his attendants remained upon shore anxious for his fate; but he at last appeared, buffeting upon the surface, holding the cup in triumph in one hand, and making his way good among the waves with the other. It may be supposed he was received with applause, upon his arrival on shore; the cup was made the reward of his adventure; the king ordered him to be taken proper care of; and, as he was somewhat fatigued and debilitated by his labour, after an hearty meal, he was put to bed, and permitted to refresh himself by sleeping.

"When his spirits were thus restored, he was again brought to satisfy the king's curiosity with a narrative of the wonders he had seen; and his account was to the following effect. He would never, he said, have obeyed the king's commands, had he been apprized of half the dangers that were before him. There were four things, he said, that rendered the gulph dreadful, not only to men, but even to the fishes themselves: first, the force of the water bursting up from the bottom, which requires great strength to resist; secondly, the abruptness of the rocks, that on every side threaten destruction; thirdly, the force of the whirlpool, dashing against those rocks; and fourthly, the number and magnitude of the polypus fish, some of which appeared as large as a man, and which every where sticking against the rocks, projected their fibrous arms to entangle him. Being asked how he was able so readily to find the cup that had been thrown in, he replied, that it happened to be flung by the waves into the cavity of a rock, against which he himself was urged in his descent. This account, however, did not satisfy the king's curiosity: being requested to



to venture once more into the gulph for further discoveries, he at first refused; but the king, desirous of having the most exact information possible of all things to be found in the gulph, repeated his solicitations; and, to give them still greater weight, produced a larger cup than the former, and added also a purse of gold. Upon these considerations, the unfortunate Pessicola once again plunged into the whirlpool, and was never heard of more.

### C H A P. XVIII.

#### A particular Account of the Mechanical Properties of AIR.

**H**AVING described the earth and the sea, we now ascend into that fluid which surrounds them both; and which, in some measure, supports and supplies all animated nature. As upon viewing the bottom of the ocean from its surface, we see an infinity of animals moving therein, and seeking food; so were some superior being to regard the earth at a proper distance, he might consider us in the same light: he might, from his superior station, behold a number of busy little beings, immersed in the aerial fluid, that every where surrounds them, and sedulously employed in procuring the means of subsistence. This fluid, though too fine for the gross perception of its inhabitants, might, to his nicer organs of sight, be very visible; and, while he at once saw into its operations, he might smile at the varieties of human conjecture concerning it: he might readily discern, perhaps, the height above the surface of the earth to which this fluid atmosphere reaches: he might exactly determine that peculiar form of its parts which gives it the spring or elasticity with which it is endued: he might distinguish which of its parts were pure incorruptible air, and which only made for a little time to assume the appearance, so as to be quickly returned back to the element from whence it came. But as for us, who are immersed at the bottom of this gulph, we must be contented with a more confined knowledge; and, wanting a proper point of prospect, remain satisfied with a combination of the effects.

One of the first things that our senses inform us of is, that although the air is too fine for our sight, it is very obvious to our touch. Although we cannot see the wind, contained in a bladder, we can very readily feel its resistance; and though the hurricane may want colour, we often fatally experience that it does not want force. We have equal experience of the air's spring or elasticity; the bladder, when pressed, returns again, upon the pressure being taken away; a bottle, when filled, often bursts, from the spring of air which is included.

So far the slightest experience reaches; but, by carrying experiment a little farther, we learn, that air also is heavy: a round glass vessel being emptied of its air, and accurately weighed, has been found lighter than when it was weighed with the air in it. Upon computing the superior weight of the full vessel, a cubic foot of air is found to weigh something more than an ounce.

From this experiment, therefore, we learn, that the earth, and all things upon its surface, are every where covered with a ponderous fluid, which rising very high over our heads, must be proportionably heavy. For instance, as in the sea, a man at the depth of twenty feet, sustains a greater weight of water than a man at the depth of but ten feet; so will a man at the bottom of a valley

have a greater weight of air over him, than a man on the top of a mountain.

From hence we may conclude, that we sustain a very great weight of air; and although, like men walking at the bottom of the sea, we cannot feel the weight which presses equally round us, yet the pressure is not the less real. As in morals, we seldom know the blessings that surround us till we are deprived of them, so here we do not perceive the weight of the ambient fluid till a part of it is taken away. If, by any means, we contrive to take away the pressure of the air from any one part of our bodies, we are soon made sensible of the weight upon the other parts. If we clap our hand upon the mouth of a vessel from whence the air has been taken away, there will thus be air on one side, and none on the other; upon which, we shall instantly find the hand violently sucked inwards, which is nothing more than the weight of the air upon the back of the hand that forces it into the space which is empty below.

As by this experiment we perceive that the air presses with great weight upon every thing on the surface of the earth, so by other experiments we learn the exact weight with which it presses. First, if the air be exhausted out of any vessel, a drinking-vessel for instance, and this vessel be set with the mouth downwards in water, the water will rise up into the empty space, and fill the inverted glass; for the external air will, in this case, press up the water, where there is no weight to resist; as, one part of a bed being pressed, makes the other parts, that have no weight upon them, rise. In this case, as was said, the water being pressed without, will rise in the glass; and would continue to rise (if the empty glass were tall enough) thirty-two feet high. In fact, there have been pipes made purposely for this experiment of above thirty-two feet high; in which, upon being exhausted, the water has always risen to the height of thirty-two feet: there it has always rested, and never ascended higher. From this, therefore, we learn, that the weight of the air which presses up the water, is equal to a pillar or column of water, which is thirty-two feet high; as it is just able to raise such a column, and no more. In other words, the surface of the earth is every where covered with a weight of air, which is equivalent to a covering of thirty-two feet deep of water; or to a weight of twenty-nine inches and an half of quicksilver, which is known to be just as heavy as the former.

Thus we see that the air at the surface of the earth is just as heavy as thirty-two feet of water, or twenty-nine inches and an half of quicksilver; and it is easily found, by computation, that to raise water thirty-two feet, will require a weight of fifteen pounds upon every square inch. Now, if we are fond of computations, we have only to calculate how many square inches are in the surface of an ordinary human body, and allowing every inch to sustain fifteen pounds, we may amaze ourselves at the weight of air we sustain. It has been computed, and found, that our ordinary load of air amounts to within a little of forty thousand pounds: this is wonderful; but wondering is not the way to grow wise.

Notwithstanding this be our ordinary load, and our usual supply, there are at different times very great variations. The air is not, like water, equally heavy at all seasons; but sometimes is lighter, and sometimes more heavy. It is sometimes more compact, and sometimes more elastic or springy, which produces the same effects as an increase of its weight. The air which at one time raises water thirty-two feet in the tube, and quick-



silver twenty-nine inches, will not at another raise the one to thirty feet, or the other to twenty-six inches. This makes, therefore, a very great difference in the weight we sustain; and we are actually known, by computation, to carry at one time four thousand pounds of air more than at another.

The reason of this surprising difference in the weight of air, is either owing to its pressure from above, or to an increase of vapour floating in it. Its increased pressure is the consequence of its spring or elasticity, which cold and heat sensibly affect, and are continually changing.

This elasticity of the air is one of its most amazing properties; and to which it should seem nothing can set bounds. A body of air that may be contained in a nut-shell, may easily, with heat, be dilated into a sphere of unknown dimensions. On the contrary, the air contained in an house, may be compressed into a cavity not larger than the eye of a needle. In short, no bounds can be set to its confinement or expansion; at least, experiment has hitherto found its attempts indefinite. In every situation, it retains its elasticity; and the more closely we compress it, the more strongly does it resist the pressure. If to the increasing the elasticity on one side by compression, we increase it on the other side by heat, the force of both soon becomes irresistible; and a certain French philosopher supposed, that air thus confined, and expanding, was sufficient for the explosion of a world.

Many instruments have been formed to measure and determine these different properties of the air; and which serve several useful purposes. The barometer serves to measure its weight; to tell us when it is heavier, and when lighter. It is composed of a glass tube or pipe, of about thirty inches in length, closed up at one end; this tube is then filled with quicksilver; this done, the maker clapping his finger upon the open end, inverts the tube, and plunges the open end, finger and all, into a basin of quicksilver, and then takes his finger away: now the quicksilver in the tube will, by its own weight, endeavour to descend into that in the basin; but the external air, pressing on the surface of the quicksilver in the basin without, and no air being in the tube at top, the quicksilver will continue in the tube, being pressed up, as was said, by the air, on the surface of the basin below. The height at which it is known to stand in the tube, is usually about twenty-nine inches, when the air is heavy; but not above twenty-six, when the air is very light. Thus, by this instrument we can, with some exactness, determine the weight of the air; and, of consequence, tell before-hand the changes of the weather. Before the fine dry weather, the air is charged with a variety of vapours, which float in it unseen, and render it extremely heavy, so that it presses up the quicksilver; or, in other words, the barometer rises. In moist, rainy weather, the vapours are washed down, or there is not heat sufficient for them to rise, so that the air is then sensibly lighter, and presses up the quicksilver with less force; or, in other words, the barometer is seen to fall. Our constitutions seem also to correspond with the changes of the weather-glass; they are braced, strong, and vigorous, with a large body of air upon them; they are languid, relaxed, and feeble, when the air is light, and refuses to give our fibres their proper tone.

But although the barometer thus measures the weight of the air with exactness enough for the general purposes of life, yet it is often affected with a thousand irregularities, that no exactness in the instrument can remedy, nor no theory account for. When high winds blow, the quicksilver generally is low: it rises higher in cold weather than in warm; and is usually higher at morning and even-

ing than at mid-day: it generally descends lower after rain than it was before it. There are also frequent changes in the air, without any sensible alteration in the barometer.

As the barometer is thus used in predicting the changes of the weather, so it is also serviceable in measuring the heights of mountains, which mathematicians cannot so readily do: for, as the higher we ascend from the surface of the earth, the air becomes lighter, so the quicksilver in the barometer will descend in proportion. It is found to sink at the rate of the tenth part of an inch for every ninety feet we ascend; so that in going up a mountain, if we find the quicksilver fallen an inch, we conclude, that we are got upon an ascent of near nine hundred feet high. In this there has been found some variation; into a detail of which, it is not the business of a natural historian to enter.

In order to determine the elasticity of air, the wind-gun has been invented, which is an instrument variously made; but in all upon the principle of compressing a large quantity of air into a tube, in which there is an ivory ball, and then giving the compressed elastic air free power to act, and drive the ball as directed. The ball thus driven will pierce a thick board: and will be as fatal, at small distances, as if driven with gunpowder. Perhaps the force of this instrument has never been assisted by means of heat; this, which could be very easily contrived by means of phosphorus, or any other hot substance applied to the barrel, would produce a greater force than gunpowder itself.

The air pump is an instrument contrived to exhaust the air from round a vessel adapted to that purpose, called a receiver. This method of exhausting, is contrived in the simple instrument, by a piston, like that of a syringe, going down into the vessel, and thus pushing out its air; which, by means of a valve, is prevented from returning into the vessel again.

But this, like all other complicated instruments, will be better understood by a minute inspection, than an hour's description: it may suffice here to observe, that by depriving animals, and other substances, of all air, it shews us what the benefits and effects of air are in sustaining life, or promoting vegetation.

The digester is an instrument of still more extraordinary effects than any of the former; and sufficiently discovers the amazing force of air, when its elasticity is augmented by fire. A common tea-kettle, if the spout were closed up, and the lid put firmly down, would serve to become a digester, if strong enough. But the instrument used for this purpose, is a strong metal pot, with a lid to screw close on, so that, when down, no air can get in or return: into this pot meat and bones are put, with a small quantity of water, and then the lid screwed close: a lighted lamp is put underneath, and, what is very extraordinary (yet equally true), in six or eight minutes the whole maws, bones and all, are dissolved into a jelly; so great is the force and elasticity of the air contained within, struggling to escape, and breaking in pieces all the substances with which it is mixed. Care, however, must be taken not to heat this instrument too violently; for then, the inclosed air would become irresistible, and burst the whole, with perhaps a fatal explosion.

There are numberless other useful instruments made to depend on the weight, the elasticity, or the fluidity of the air, which do not come within the plan of the present work; the design of which is not to give an account of the inventions that have been made for determining the nature and properties of air, but a mere narrative of its effects. The description of the pump, the forcing-pump, the fire-engine, the steam-engine, the syphon, and many



many others, belong not to the naturalist, but the experimental philosopher: the one gives an history of Nature, as he finds she presents herself to him, and he draws the obvious picture: the other pursues her with close investigation, tortures her by experiment to give up her secrets, and measures her latent qualities with laborious precision. Much more, therefore, might be said of the mechanical effects of air, and of the conjectures that have been made respecting the form of its parts: how some have supposed them to resemble little hoops, coiled up in a spring; others, like fleeces of wool; others, that the parts are endued with a repulsive quality, by which, when squeezed together, they endeavour to fly off, and recede from each other. We might have given the disputes relative to the height to which this body of air extends above us, and concerning which there is no agreement. We might have enquired how much of the air we breathe is elementary, and not reducible to any other substance; and of what density it would become, if it were supposed to be continued down to the center of the earth. At that place we might, with the help of figures, and a bold imagination, have shewn it twenty thousand times heavier than its bulk of gold. We might also prove it millions of times purer than upon earth, when raised to the surface of the atmosphere. But these speculations do not belong to natural history; and they have hitherto produced no great advantages in that branch of science to which they more properly appertain.

#### CHAP. XIX.

#### NATURAL HISTORY of the AIR.

OUR atmosphere has been considered by a late eminent philosopher, as one large chemical vessel, in which a great number of various operations are constantly performing. In it all the bodies of the earth are continually sending up a part of their substance by evaporation, to mix in this great alembic, and to float a-while in common. Here minerals, from their lowest depths, ascend in noxious, or in warm vapours, to make a part of the general mass; seas, rivers, and subterraneous springs, furnish their copious supplies; plants receive and return their share; and animals, that by living upon, consume this general store, are found to give it back in greater quantities, when they die. The air, therefore, that we breathe, and upon which we subsist, bears very little resemblance to that pure elementary body which was described in the last chapter; and which is rather a substance that may be conceived, than experienced to exist. Air, such as we find it, is one of the most compounded bodies in all nature. Water may be reduced to a fluid every way resembling air, by heat; which, by cold, becomes water again. Every thing we see gives off its parts to the air, and has a little floating atmosphere of its own round it. The rose is encompassed with a sphere of its own odorous particles; while the nightshade infects the air with scents of a more ungrateful nature. The perfume of musk flies off in such abundance, that the quantity remaining becomes sensibly lighter by the loss. A thousand substances that escape all our senses, we know to be there; the powerful emanations of the load-stone, the effluvia of electricity, the rays of light, and the insinuations of fire. Such are the various substances through which we move, and which we are constantly taking in at every pore, and returning again with imperceptible discharge. This great solution, or mixture of all earthly bodies, is continually operating upon itself; which, perhaps, may be the cause of its unceasing motion:

but it operates still more visibly upon such grosser substances as are exposed to its influence; for scarce any substance is found capable of resisting the corroding qualities of the air. The air, say the chemists, is a chaos, furnished with all kinds of salts and menstrooms; and therefore, it is capable of dissolving all kinds of bodies. It is well known, that copper and iron are quickly covered, and eaten with rust; and that in the climates near the equator, no art can keep them clean. In those dreary countries, the instruments, knives and keys, that are kept in the pocket, are nevertheless quickly encrusted; and the great guns, with every precaution, after some years, become useless. Stones, as being less hard, may be readily supposed to be more easily soluble. The marble of which the noble monuments of Italian antiquity are composed, although in one of the finest climates in the world, shew the impressions which have been made upon them by the air. In many places they seem worm eaten by time; and, in others, they appear crumbling into dust. Gold alone seems to be exempted from this general state of dissolution; it is never found to contract rust, though exposed never so long: the reason of this seems to be, that sea-salt, which is the only menstruum capable of acting upon, and dissolving gold, is but very little mixed with the air; for salt being a very fixed body, and not apt to volatilize, and rise with heat, there is but a small proportion of it in the atmosphere. In the laboratories, and shops, however, where salt is much used, and the air is impregnated with it, gold is found to rust as well as other metals.

Bodies of a softer nature are obviously destroyed by the air. Mr. Boyle says, that silks brought to Jamaica, will, if there exposed to the air, rot even while they preserve their colour; but if kept therefrom, they both retain their strength and gloss. The same happens in Brasil, where their cloaths, which are black, soon turn of an iron colour; though, in the shops, they preserve their proper hue. In these tropical climates also, such are the putrescent qualities of the air, that white sugar will sometimes be full of maggots. Drugs and plasters lose their virtue, and become verminous. In some places they are obliged to expose their sweetmeats by day in the sun, otherwise the night air would quickly cause them to putrify. On the contrary, in the cold arctic regions, animal substances, during their winter, are never known to putrify; and meat may be kept for months, without any salt whatsoever. This experiment happily succeeded with the eight Englishmen that were accidentally left upon the inhospitable coasts of Greenland, at a place where seven Dutchmen had perished but a few years before; for killing some rein-deer for their subsistence, and having no salt to preserve the flesh, to their great surprize, they soon found it did not want any, as it remained sweet during their eight months continuance upon that shore.

These powers with which air is endued over unorganized substances, are exerted in a still stronger manner over plants, animals of an inferior nature, and, lastly, over man himself. Most of the beauty, and the luxuriance of vegetation, is well known to be derived from the benign influence of the air: and every plant seems to have its favourite climate, not less than its proper soil. The lower ranks of animals also, seem formed for their respective climates, in which only they can live. Man alone seems the child of every climate, and capable of existing in all. However, this peculiar privilege does not exempt him from the influences of the air; he is as much subject to its malignity, as the meanest insect or vegetable.

With regard to plants, air is absolutely necessary for their life and preservation, that they will not vegetate



vegetate in an exhausted receiver. All plants have within them a quantity of air, which supports and agitates their juices. They are continually imbibing fresh nutriment from the air, to increase this store, and to supply the wants which they sustain from evaporation. When, therefore, the external air is drawn from them, they are no longer able to subsist. Even that quantity of air which they before were possessed of, escapes through their pores, into the exhausted receiver; and as this continues to be pumped away, they become languid, grow flaccid, and die. However, the plant or flower thus ceasing to vegetate, is kept, by being secured from the external air, a much longer time sweet than it would have continued, had it been openly exposed.

That air which is so necessary to the life of vegetables, is still more so to that of animals; there are none found, how seemingly torpid soever, that do not require their needful supply. Fishes themselves will not live in water from whence the air is exhausted; and it is generally supposed that they die in frozen ponds, from the want of this necessary to animal existence. Many have been the animals that idle curiosity has tortured in the prison of a receiver, merely to observe the manner of their dying. We shall, from a thousand instances, produce that of the viper, as it is known to be one of the most vivacious reptiles in the world; and as we shall feel but little compassion for its tortures. Mr. Boyle took a new-caught viper, and shutting it up into a small receiver, began to pump away the air. At first, upon the air's being drawn away, it began to swell; some time after he had done pumping, it began to gape, and open its jaws; being thus compelled to open its jaws, it once more resumed its former lankness; it then began to move up and down within, as if to seek for air, and after a while foamed a little, leaving the foam sticking to the inside of the glass; soon after the body and neck grew prodigiously tumid, and a blister appeared upon its back; an hour and an half after the receiver was exhausted, the distended viper moved, and gave manifest signs of life; the jaws remained quite distended; as it were from beneath the epiglottis, came the black tongue, and reached beyond it; but the animal seemed, by its posture, not to have any life; the mouth also was grown blackish within; and in this situation it continued for twenty-three hours. But upon the air's being re-admitted, the viper's mouth was presently closed, and soon after opened again; and for some time those motions continued, which argued the remains of life. Such is the fate of the most insignificant or minute reptile that can be thus included. Mice, fleas, and even the little eels that are found swimming in vinegar, die for want of air. Not only these, but the eggs of these animals, will not produce in vacuo, but require air to bring them to perfection.

As in this manner air is necessary to their subsistence, so also it must be of a proper kind, and not impregnated with foreign mixtures. That factitious air which is pumped from plants or fluids, is generally, in a short time, fatal to them. Mr. Boyle has given us many experiments to this purpose. After having shewn that all vegetable, and most mineral substances, properly prepared, may afford air, by being placed in an exhausted receiver, and this in such quantities, that some have thought it a new substance, made by the alteration which the mineral or plant has undergone by the texture of its parts being loosened in the operation—having shewn, that this air may be drawn in great quantities from vegetable, animal, or mineral substances, such as apples, cherries, amber burnt, or hartshorn—he included a frog in artificial air, produced from paste; in seven minutes space it suf-

fered convulsions, and at last lay still, and being taken out, recovered no motion at all, but was dead. A bird enclosed in artificial air, from raisins, died in a quarter of a minute, and never stirred more. A snail was put into the receiver, with air of paste; in four minutes it ceased to move, and was dead, although it had survived in vacuo for several hours: so that factitious air proved a greater enemy to animals than even a vacuum itself.

Air also may be impregnated with fumes that are instantly fatal to animals. The fumes of hot iron, copper, or any other heated metal, blown into the place where an animal is confined, instantly destroy it. We have already mentioned the vapours in the grotto Del Cane suffocating a dog. The ancients even supposed, that these animals, as they always ran with their noses to the ground, were the first that felt any infection. In short, it should seem that the predominance of any one vapour, from any body, how wholesome soever in itself, becomes infectious; and that we owe the salubrity of the air to the variety of its mixture.

But there is no animal whose frame is more sensibly affected by the changes of the air than man. It is true; he can endure a greater variety of climates than the lower orders generally are able to do; but it is rather by the means which he has discovered of obviating their effects, than by the apparent strength of his constitution. Most other animals can bear cold or hunger better; endure greater fatigues in proportion, and are satisfied with shorter repose. The variations of the climate, therefore, would probably affect them less, if they had the same means or skill in providing against the severities of the change. However this be, the body of man is an instrument much more nicely sensible of the variations of the air, than any of those which his own art has produced; for his frame alone seems to unite all their properties, being invigorated by the weight of the air, relaxed by its moisture, enfeebled by its heat, and stiffened by its frigidity.

But it is chiefly by the predominance of some peculiar vapour, that the air becomes unfit for human support. It is often found by dreadful experience, to enter into the constitution, to mix with its juices, and to putrify the whole mass of blood. The nervous system is not less affected by its operations; palsies and vertigoes are caused by its damps; and a still more fatal train of distempers by its exhalations. In order that the air should be wholesome, it is necessary, as we have seen, that it should not be of one kind, but the compound of several substances; and the more various the composition, to all appearance the more salubrious. A man, therefore, who continues in one place, is not so likely to enjoy this wholesome variety, as he who changes his situation; and, if we may so express it, instead of waiting for a renovation of air, walks forward to meet his arrival. This mere motion, independent even of the benefits of exercise, becomes wholesome, by thus supplying a great variety of that healthful fluid by which we are sustained.

A thousand accidents are found to increase these bodies of vapour, that make one place more or less wholesome than another. Heat may raise them in too great quantities; and cold may stagnate them. Minerals may give off their effluvia in such proportion as to keep away all other kind of air; vegetables may render the air unwholesome by their supply; and animal putrefaction seems to furnish a quantity of vapour, at least as noxious as any of the former. All these united, generally make up the mass of respiration, and are, when mixed together, harmless; but any one of them, for a long



long time singly predominant, becomes at length fatal.

The effects of heat in producing a noxious quality in the air, are well known. Those torrid regions under the Line, are always unwholesome. At Senegal the natives consider forty as a very advanced time of life, and generally die of old age at fifty. At Carthage, in America, where the heat of the hottest day ever known in Europe is continual, where, during their winter season, these dreadful heats are united with a continual succession of thunder, rain, and tempests, arising from their intenseness, the wan and livid complexions of the inhabitants might make strangers suspect that they were just recovered from some dreadful distemper; the actions of the natives are conformable to their colour; in all their motions there is somewhat relaxed and languid; the heat of the climate even affects their speech, which is soft and slow, and their words generally broken. Travellers from Europe retain their strength and ruddy colour in that climate, possibly for three or four months; but afterwards suffer such decays in both, that they are no longer to be distinguished from the inhabitants by their complexion. However, this languid and spiritless existence is frequently drawled on sometimes even to eighty. Young persons are generally most affected by the heat of climate, which spares the more aged; but all, upon their arrival on the coasts, are subject to the same train of fatal disorders. Few nations have experienced the mortality of these coasts, so much as our own: in our unsuccessful attack upon Carthage, more than three parts of our army were destroyed by the climate alone; and those that returned from that fatal expedition, found their former vigour irretrievably gone. In our more fortunate expedition, which gave us the Havana, we had little reason to boast of our success; instead of a third, not a fifth part of the army were left survivors of their victory, the climate being an enemy that even heroes cannot conquer.

The distempers that thus proceed from the cruel malignity of those climates are many; that, for instance, called the Chapotonadas, carries off a multitude of people; and extremely thins the crews of European ships, whom gain tempts into those inhospitable regions. The nature of this distemper is but little known, being caused in some persons by cold, in others by indigestion. But its effects are far from being obscure; it is generally fatal in three or four days: upon its seizing the patient, it brings on what is there called the black vomit, which is the sad symptom after which none are ever found to recover. Some, when the vomit attacks them, are seized with a delirium, that, were they not tied down, they would tear themselves to pieces, and thus expire in the midst of this furious paroxysm. This disorder, in milder climates, takes the name of the bilious fever, and is attended with milder symptoms, but very dangerous in all.

There are many other disorders incident to the human body, that seem the offspring of heat; but to mention no other, that very lassitude which prevails in all the tropical climates, may be considered as a disease. The inhabitants of India, says a modern philosopher, sustain an unceasing languor from the heats of their climate; and are torpid in the midst of profusion. For this reason, the great Disposer of Nature has clothed their country with trees of an amazing height, whose shade might defend them from the beams of the sun; and whose continual freshness might, in some measure, temperate their fierceness. From these shades, therefore, the air receives refreshing moisture, and animals a cooling protection. The whole race of

savage animals retire, in the midst of the day, to the very center of the forests, not so much to avoid their enemy man, as to find a defence against the raging heats of the season. This advantage which arises from shade in torrid climates, may probably afford a solution for that extraordinary circumstance related by Boyle, which he imputes to a different cause. In the island of Ternate, belonging to the Dutch, a place that had been long celebrated for its beauty and healthfulness, the clove-trees grew in such plenty, that they in some measure lessened their own value: for this reason, the Dutch resolved to cut down the forests, and thus to raise the price of the commodity: but they had soon reason to repent of their avarice; for such a change ensued, by cutting down the trees, that the whole island, from being healthy and delightful, having lost its charming shades, became extremely sickly, and has actually continued so to this day. Boerhaave considered heat so prejudicial to health, that he was never seen to go near a fire.

An opposite set of calamities are the consequence, in climates where the air is condensed by cold. In such places, all that train of distempers which are known to arise from obstructed perspiration, are very common; eruptions, boils, scurvy, and a loathsome leprosy, that covers the whole body with a scurf, and white putrid ulcers. These disorders also are infectious; and, while they thus banish the patient from society, they generally accompany him to the grave. The men of those climates seldom attain to the age of fifty; but the women, who do not lead such laborious lives, are found to live longer.

The autumnal complaints which attend a wet summer, indicate the dangers of a moist air. The long continuance of an east wind also, shews the prejudice of a dry one. Mineral exhalations, when copious, are every where known to be fatal; and although we probably owe the increase and luxuriance of vegetation to a moderate degree of their warmth, yet the natives of those countries where there are mines in plenty, but too often experience the noxious effects of their vicinity. Those trades also that deal in the preparations of metals of all kinds, are always unwholesome; and the workmen, after some time, are generally seen to labour under palsies, and other nervous complaints. The vapours from some vegetable substances, are well known to be attended with dangerous effects. The shade of the machinet-tree, in America, is said to be fatal; as was that of the juniper, if we may credit the ancients. Those who walk through fields of poppies, or in any manner prepare those flowers, for making opium, are very sensibly affected with the drowsiness they occasion. A physician of Mr. Boyle's acquaintance, causing a large quantity of black hellebore to be pounded in a mortar, most of the persons who were in the room, and especially the person who pounded it, were purged by it, and some of them strongly. He also gathered a certain plant in Ireland, which the person who beat in a mortar, and the physician who was standing near, were so strongly affected by, that their hands and faces swelled to an enormous size, and continued tumid for a long time after.

But neither mineral nor vegetable steams are so dangerous to the constitution, as those proceeding from animal substances, putrifying either by disease or death. The effluvia that comes from diseased bodies, propagate that frightful catalogue of disorders which are called infectious. The parts which compose vegetable vapours, and mineral exhalations, seem gross and heavy, in comparison of these volatile vapours, that go to great distances, and have been described as spreading desolation



defolation over the whole earth. They fly every where; penetrate every where; and the vapours that fly from a single disease, soon render it epidemic.

The plague is the first upon the list in this class of human calamities. From whence this scourge of man's presumption may have its beginning, is not well known; but we well know that it is propagated by infection. Whatever be the general state of the atmosphere, we learn from experience, that the noxious vapours, though but singly introduced at first, taints the air by degrees: every person infected, tends to add to the growing malignity; and, as the disorder becomes more general, the putrescence of the air becomes more noxious, so that the symptoms are aggravated by continuance. When it is said that the origin of this disorder is unknown, it implies, that the air seems to be but little employed in first producing it. There are some countries, even in the midst of Africa, that we learn have never been infected with it; but continue, for centuries, unmolested. On the contrary, there are others, that are generally visited once a year, as in Egypt, which, nevertheless, seems peculiarly blessed with the serenity and temperature of its climate. In the former countries, which are of vast extent, and many of them very populous, every thing should seem to dispose the air to make the plague continual among them. The great heats of the climate, the unwholesomeness of the food, the sloth and dirt of the inhabitants, but, above all, the bloody battles which are continually fought among them, after which heaps of dead bodies are left unburied, and exposed to putrefaction. All these one might think would be apt to bring the plague among them; and yet, nevertheless, we are assured by Leo Africanus, that in Numidia the plague is not known once in an hundred years; and that in Negroland, it is not known at all. This dreadful disorder, therefore, must have its rise, not from any previous disposition of the air, but from some particular cause, beginning with one individual, and extending the malignity, by communication, till at last the air becomes actually tainted by the generality of the infection.

The plague which spread itself over the whole world, in the year 1346, as we are told by Mezeray, was so contagious, that scarce a village, or even an house, escaped being infected by it. Before it had reached Europe, it had been for two years travelling from the great kingdom of Cathay, where it began by a vapour most horridly fetid; this broke out of the earth like a subterranean fire, and upon the first instant of its eruption, consumed, and desolated above two hundred leagues of that country, even to the trees and stones.

In that great plague which desolated the city of London, in the year 1665, a pious and learned schoolmaster of Mr. Boyle's acquaintance, who ventured to stay in the city, and took upon him the humane office of visiting the sick and the dying, who had been deserted by better physicians, averred, that being once called to a poor woman who had buried her children of the plague, he found the room where she lay so little that it scarce could hold any more than the bed whereon she was stretched. However, in this wretched abode, beside her, in an open coffin, her husband lay, who had some time before died of the same disease; and whom she, poor creature, soon followed. But what shewed the peculiar malignity of the air, thus suffering from animal putrefaction, was, that the contagious steams had produced spots on the very wall of their wretched apartment; and Mr. Boyle's own study, which was contiguous to a pest-house, was also spotted in the same frightful manner. Happily for mankind, this disorder, for more than a century,

has not been known in our island; and, for this last age, has abated much of its violence, even in those countries where it is most common. Diseases, like empires, have their revolutions; and those which for a while were the scourge of mankind, sink unheard of, to give place to new ones, more dreadful, as being less understood.

For this revolution in disorders, which has employed the speculation of many, Mr. Boyle accounts in the following manner: "Since," says he, "there want not causes in the bowels of the earth, to make considerable changes amongst the materials that nature has plentifully treasured up in those magazines, and as those noxious steams are abundantly supplied to the surface, it may not seem improbable, that in this great variety, some may be found capable of particularly affecting the human frame in a particular manner, and thus of producing new diseases. The duration of these may be greater or less, according to the lastingness of those subterraneous causes that produced them. On which account, it need be no wonder that some diseases have but a short duration, and vanish not long after they appear; whilst others may continue longer, as having under ground more settled and durable causes to maintain them."

From the recital of this train of mischiefs produced by the air, upon minerals, plants, animals, and man himself, a gloomy mind may be apt to dread this indulgent nurse of nature as a cruel and an inexorable step-mother; but it is far otherwise; and, although we are sometimes injured, yet almost all the comforts and blessings of life spring from its propitious influence. It would be needless to observe, that it is absolutely necessary for the support of our lives; for of this, every moment's experience assures us. But how it contributes to this support, is not so readily comprehended. All allow it to be a friend, to whose benefits we are constantly obliged: and yet, to this hour, philosophers are divided as to the nature of the obligation. The dispute is, whether the air is only useful by its weight to force our juices into circulation; or, whether, by containing a peculiar spirit, it mixes with the blood in our vessels, and acts like a spur to their industry. Perhaps it may exert both these useful offices at the same time. Its weight may give the blood its progressive motion, through the larger vessels of the body; and its admixture with it, cause those contractions of all the vessels, which serve to force it still more strongly forward, through the minutest channels of the circulation. Be this as it may, it is well known, that that part of our blood which has just received the influx of the air in our bodies, is of a very different colour from that which has almost performed its circuit. It has been found, that the arterial blood which has been immediately mixed with the air in the lungs, and, if we may so express it, is just beginning its journey through the body, is of a fine florid scarlet colour; while, on the contrary, the blood of the veins that is returning from having performed its duty, is of a blackish crimson hue. Whence this difference of colour should proceed, is not well understood; we only know the fact, that this florid colour is communicated by the air; and we are well convinced, that this air has been admitted into the blood for very useful purposes.

Besides this vital principle in animals, the air also gives life and body to flame. A candle quickly goes out in an exhausted receiver; for having soon consumed the quantity of air, it then expires, for want of a fresh supply. There has been a flame contrived that will burn under water; but none yet has been found, that will continue to burn without air. Gunpowder, which is the most catching and powerful fire we know, will not go off in an exhausted



hausted receiver; nay, if a train of gunpowder be laid, so as that one part may be fired in the open air, yet the other part in vacuo will remain untouched, and unconsumed. Wood also set on fire, immediately goes out; and its flame ceases upon removing the air; for something is then wanting to press the body of the fire against that of the fuel, and to prevent the too speedy diffusion of the flame. We frequently see cooks, and others, whose business it is to keep up strong fires, take proper precautions to exclude the beams of the sun from shining upon them, which effectually puts them out. This they are apt to ascribe to a wrong cause; namely, the operation of the light: but the real fact is, that the warmth of the sun-beams lessen and dissipate the body of the air that goes to feed the flame; and the fire, of consequence, languishes for want of a necessary supply.

The air, while it thus kindles fire into flame, is notwithstanding found to moderate the rays of light, to dissipate their violence, and to spread an uniform lustre over every object. Were the beams of the sun to dart directly upon us, without passing through this protecting medium, they would either burn us up at once, or blind us with their effulgence. But by going through the air, they are reflected, refracted, and turned from their direct course, a thousand different ways; and thus are more evenly diffused over the face of nature.

Among the other necessary benefits the air is of to us, one of the principal is its conveyance of sound. Even the vibrations of a bell, which have the loudest effect that we know of, cease to be heard, when under the receiver of an air-pump. Thus all the pleasures we receive from conversation with each other, or from music, depend entirely upon the air.

Odours likewise are diffused only by the means of air; without this fluid to swim in, they would for ever remain torpid in their respective substances; and the rose would affect us with as little sensations of pleasure, as the thorn on which it grew.

Those who are willing to augment the catalogue of the benefits we receive from this element, assert also, that tastes themselves would be insipid, were it not that the air presses their parts upon the nerves of the tongue and palate, so as to produce their grateful effects. Thus, continue they, upon the tops of high mountains, as on the Pike of Teneriff, the most poignant bodies, as pepper, ginger, salt, and spice, have no sensible taste, for want of their particles being thus sent home to the sensory. But we owe the air sufficient obligations, not to be studious of admitting this among the number: in fact, all substances have their taste, as well on the tops of mountains, as in the bottom of the valley; and several have been known to eat a good dinner on the Alps.

It is sufficient, therefore, that we regard the air as the parent of health and vegetation; as a kind dispenser of light and warmth; and as the conveyer of sounds and odours. This is an element of which avarice will not deprive us; and which power cannot monopolize. The treasures of the earth, the verdure of the fields, and even the refreshments of the stream, are too often seen going only to assist the luxuries of the great; while the less fortunate part of mankind stand humble spectators of their encroachments. But the air no limitations can bound, nor any land-marks restrain. In this benign element, all mankind can boast an equal possession; and for this we all have equal obligations to Heaven. We consume a part of it, for our own sustenance, while we live; and, when we die, our putrifying bodies give back the supply, which, during life, we had accumulated from the general mass.

## CHAP. XX.

## Of Regular and Irregular WINDS.

**W**IND is a current of air. Experimental philosophers produce an artificial wind, by an instrument called an æolipyle. This is nothing more than an hollow copper ball, with a long pipe; a tea-kettle might be readily made into one, if it were entirely closed at the lid, and the spout left open; through this spout it is to be filled with water, and then set upon the fire, by which means it produces a violent blast, like wind, which continues while there is any water remaining in the instrument. In this manner water is converted into a rushing air; which, if caught as it goes out, and left to cool, is again quickly converted into its former element. Besides this, as was mentioned in the former chapter, almost every substance contains some portions of air. Vegetables, or the bodies of animals left to putrify, produce it in a very copious manner. But it is not only seen thus escaping from bodies, but it may be very easily made to enter into them. A quantity of air may be compressed into water, so as to be intimately blended with it. It finds a much easier admission into wine, or any fermented liquor; and still easier, into spirits of wine. Some salts suck up the air in such quantities, that they are made sensibly heavier thereby, and often are melted by its moisture. In this manner, most bodies, being found either capable of receiving or affording it, we are not to be surprized at those streams of air that are continually fleeing round the globe. Minerals, vegetables, and animals, contribute to increase the current; and are sending off their constant supplies. These, as they are differently affected by cold or heat, by mixture or putrefaction, all yield different quantities of air at different times; and the loudest tempests, and most rapid whirlwinds, are formed for their united contributions.

The sun is the principal instrument in rarefying the juices of plants, so as to give an escape to their imprisoned air; it is also equally operative in promoting the putrefaction of animals. Mineral exhalations are more frequently raised by subterranean heat. The moon, the other planets, the seasons, are all combined in producing these effects in a smaller degree. Mountains give a direction to the courses of the air. Fires carry a current of air along their body. Night and day alternately chill and warm the earth, and produce an alternate current of its vapours. These, and many other causes, may be assigned for the variety, and the activity of the winds, their continual change, and uncertain duration.

With us on land, as the wind proceeds from so many causes, and meets such a variety of obstacles, there can be but little hopes of ever bringing its motions to conform to theory; or of foretelling how it may blow a minute to come. The great Bacon, indeed, was of opinion, that by a close and regular history of the winds, continued for a number of ages together, and the particulars of each observation reduced to general maxims, we might at last come to understand the variations of this capricious element; and that we could foretell the certainty of a wind, with as much ease as we now foretell the return of an eclipse. Indeed, his own beginnings in this arduous undertaking, seem to speak the possibility of success; but, unhappily for mankind, this investigation is the work of ages, and we want a Bacon to direct the process.

To be able, therefore, with any plausibility, to account for the variations of the wind upon land, is not to be at present expected; and to understand any thing of their nature, we must have recourse to those



those places where they are more permanent and steady. This uniformity and steadiness we are chiefly to expect upon the ocean. There, where there is no variety of substances to furnish the air with various and inconstant supplies; where there are no mountains to direct the course of its current, but where all is extensively uniform and even; in such a place, the wind arising from a simple cause, must have but one simple motion. In fact, we find it so. There are many parts of the world where the winds, that with us are so uncertain, pay their stated visits. In some places, they are found to blow one way by day, and another by night; in others, for one-half of the year, they go in a direction contrary to their former course: but what is more extraordinary still, there are some places where the winds never change, but for ever blow the same way. This is particularly found to obtain between the tropics in the Atlantic and Æthiopic oceans; as well as in the great Pacific sea.

Few things can appear more extraordinary to a person who has never been out of our variable latitudes, than this steady wind, that for ever sits in the sail, sending the vessel forward; and as effectually preventing its return. He who has been taught to consider that nothing in the world is so variable as the winds, must certainly be surprised to find a place where there is nothing more uniform. With us their inconstancy has become a proverb; with the natives of those distant climates, they may talk of a friend or a mistress as fixed and unchangeable as the winds, and mean a compliment by the comparison. When our ships are once arrived into the proper latitudes of the great Pacific ocean, the mariner forgets the helm, and his skill becomes almost useless: neither storms nor tempests are known to deform the glassy bosom of that immense sheet of waters; a gentle breeze, that for ever blows in the same direction, rests upon the canvas, and speeds the navigator. In the space of six weeks, ships are thus known to cross an immense ocean, that takes more than so many months to return. Upon returning, the trade-wind, which has been propitious, is then avoided; the mariner is generally obliged to steer into the northern latitudes, and to take the advantage of every casual wind that offers, to assist him into port. This wind, which blows with such constancy one way, is known to prevail not only in the Pacific ocean, but also in the Atlantic, between the coasts of Guinea and Brazil; and, likewise, in the Æthiopic ocean. This seems to be the great universal wind, blowing from the east to the west, that prevails in all the extensive oceans, where the land does not frequently break the general current. Were the whole surface of the globe an ocean, there would probably be but this one wind, for ever blowing from the east, and pursuing the motions of the sun westward. All the other winds seem subordinate to this; and many of them are made from the deviations of its current. To form, therefore, any conception relative to the variations of the wind in general, it is proper to begin with that which never varies.

There have been many theories to explain this invariable motion of the winds; among the rest, we cannot omit that of Doctor Kyffer, for its strangeness: "The sea," says he, "in those latitudes, is generally covered over with green weeds, for a great extent; and the air produced from the vegetable perspiration of these, produces the trade-wind." The theory of Cartesius was not quite so absurd. He alledged, that the earth went round faster than its atmosphere at the equator; so that its motion, from west to east, gave the atmosphere an imaginary one from east to west; and thus an east wind was eternally seen to prevail. Rejecting those arbitrary opinions, conceived without force,

and asserted without proof, Doctor Halley has given one more plausible; which seems to be the reigning system of the day.

To conceive his opinion clearly, let us for a moment suppose the whole surface of the earth to be an ocean, and the air encompassing it on every side, without motion. Now it is evident, that that part of the air which lies directly under the beams of the sun, will be rarefied; and if the sun remained for ever in the same place, there would be a great vacuity in the air (if it may be so expressed) beneath the place where the sun stood. The sun moving forward, from east to west, this vacuity will follow too, and still be made under it. But while it goes on to make new vacuities, the air will rush in to fill up those the sun has already made; in other words, as it is still travelling forward, the air will continually be rushing in behind, and pursue its motions from east to west. In this manner, the air is put into motion by day; and by night, the parts continue to impel each other, till the next return of the sun, that gives a new force to the circulation.

In this manner is explained the constant east wind that is found blowing round the globe, near the equator. But it is also known, that as we recede from the equator on either side, we come into a trade-wind, that continually blows from the poles; from the north on one side, or the south on the other, both directing towards the equator. This also proceeds from a similar cause with the former; for the air being more rarefied in those places over which the sun more directly casts its rays, the currents will come both from the north and the south to fill up the intermediate vacuity.

These two motions, namely, the general one from east to west, and the more particular one from both the poles, will account for all the phenomena of trade-winds; which, if the whole surface of the globe were sea, would undoubtedly be constant, and for ever continue to blow in one direction. But there are a thousand circumstances to break these air-currents into smaller ones; to drive them back against their general course; to raise or depress them; to condense them into storms; or to whirl them in eddies. In consequence of this, regard must be often had to the nature of the soil, the position of the high mountains, the course of the rivers, and even to the luxuriance of vegetation.

If a country lying directly under the sun, be very flat and sandy, and if the land be low and extensive, the heats occasioned by the reflection of the sun-beams, produces a very great rarefaction of the air. The deserts of Africa, which are conformable to this description, are scarce ever fanned by a breath of wind by day; but the burning sun is continually seen blazing in intolerable splendor above them. For this reason, all along the coasts of Guinea, the wind is always perceived blowing in upon land, in order to fill up the vacuity caused by the sun's operation. In those shores, therefore, the wind blows in a contrary direction to that of its general current; and is constantly found setting in from the west.

From the same cause it happens, that those constant calms, attended with deluges of rain, are found in the same part of the ocean. For this tract being placed in the middle, between the westerly winds blowing on the coast of Guinea, and the easterly trade-winds that move at some distance from shore, in a contrary direction, the tendency of that part of the air that lies between these two opposite currents, is indifferent to either, and so rests between both in torpid serenity; and the weight of the incumbent atmosphere, being diminished by the continual contrary winds blowing from hence,



it is unable to keep the vapours suspended that are copiously borne thither; so that they fall in continual rains.

But it is not to be supposed, that any theory can account for all the phenomena of even those winds that are known to be most regular. Instead of a complete system of the trade-winds, we must rather be content with an imperfect history. These, as was said, being the result of a combination of effects, assume as great a variety as the causes producing them are various.

Besides the great general wind above mentioned, in those parts of the Atlantic that lie under the temperate zone, a north wind prevails constantly during the months of October, November, December, and January. These, therefore, are the most favourable months for embarking for the East-Indies, in order to take the benefit of these winds, for crossing the line: and it has been often found, by experience, that those who had set sail five months before, were not in the least farther advanced in their voyage, than those who waited for the favourable wind. During the winter of Nova Zembla, and the other arctic countries, a north wind reigns almost continually. In the Cape de Verde islands, a south wind prevails during the month of July. At the Cape of Good Hope, a north-west wind blows during the month of September. There are also regular winds, produced by various causes, upon land. The ancient Greeks were the first who observed a constant breeze, produced by the melting of the snows, in some high neighbouring countries. This was perceived in Greece, Thrace, Macedonia, and the Ægean sea. The same kind of winds are now remarked in the kingdom of Congo, and the most southern parts of Africa. The flux and reflux of the sea also produces some regular winds, that serve the purposes of trade; and, in general, it may be observed, that wherever there is a strong current of water, there is a current of air that seems to attend it.

Besides these winds that are found to blow in one direction, there are, as was said before, others that blow for certain months of the year one way, and the rest of the year the contrary way: these are called the Monsoons, from a famous pilot of that name, who first used them in navigation with success. In all that part of the ocean that lies between Africa and India, the east winds begin at the month of January, and continue till about the commencement of June. In the month of August, or September, the contrary direction takes place; and the west winds prevail for three or four months. The interval between these winds, that is to say, from the end of June to the beginning of August, there is no fixed wind; but the sea is usually tossed by violent tempests, proceeding from the north. These winds are always subject to their greatest variations, as they approach the land; so that on one side of the great peninsula of India, the coasts are, for near half the year, harrassed by violent hurricanes, and northern tempests; while, on the opposite side, and all along the coasts of Coromandel, these dreadful tempests are wholly unknown. At Java, and Ceylon, a west wind begins to reign in the month of September; but at fifteen degrees of south latitude, this wind is found to be lost, and the great general trade wind from the east, is perceived to prevail. On the contrary, at Cochin, in China, the west wind begins at March: so that these Monsoons prevail, at different seasons, throughout the Indies. So that the mariner takes one part of the year to go from Java to the Moluccas, another from Cochin to Molucca, another from Molucca to China, and still another to direct him from China to Japan.

There are winds also that may be considered as peculiar to certain coasts; for example, the south

wind is almost constant upon the coasts of Chili and Peru; western winds almost constantly prevail on the coast of Terra Magellanica; and in the environs of the Streights le Maire. On the coasts of Malabar, north and north-west winds prevail continually; along the coast of Guinea, the north-west wind is also very frequent; and, at a distance from the coasts, the north-east is always found prevailing. From the beginning of November to the end of December, a west wind prevails on the coasts of Japan; and, during the whole winter, no ships can leave the port of Cochin, on account of the impetuosity of the winds that set upon the coast. These blow with such vehemence, that the ports are entirely choked up with sand, and even boats are not able to enter. However, the east winds that prevail for the other half of the year, clear the mouths of the harbours from the accumulations of the preceding winter, and set the confined ships at liberty. At the Streights of Babelmandel there is a south wind, that periodically returns, and which is always followed by a north-east.

Besides winds thus peculiar to certain coasts, there are others found to prevail on all the coasts, in warm climates; which, during one part of the day, blow from the shore, and, during another part of it, blow from the sea. The sea-breeze, in those countries, as Dampier observes, commonly rises in the morning, about nine, proceeding slowly, in a fine small black curl, upon the surface of the water, and making its way to refresh the shore. It is gentle at first, but increases gradually till twelve, then insensibly sinks away, and is totally hushed at five. Upon its ceasing, the land-breeze begins to take its turn, which increases till twelve at night, and is succeeded, in the morning, by the sea breeze again. Without all doubt, nothing could have been more fortunate, for the inhabitants of the warm countries, where those breezes blow, than this alternate refreshment, which they feel at those seasons when it is most wanted. The heat, on some coasts, would be insupportable, were it not for such a supply of air, when the sun has rarefied all that which lay more immediately under the coast. The sea-breeze tempers the heat of the sun by day; and the land-breeze corrects the malignity of the dews, and vapours, by night. Where these breezes, therefore, prevail, and they are very common, the inhabitants enjoy a share of health and happiness, unknown to those that live much farther up the country, or such as live in similar latitudes without this advantage. The cause of these obviously seems to arise from the rarefaction of the air by the sun, as their duration continues with its appearance, and alters when it goes down. The sun, it is observed, equally diffusing his beams upon land and sea, the land, being a more solid body than the water, receives a greater quantity of heat, and reflects it more strongly. Being thus, therefore, heated to a greater degree than the waters, it, of consequence, drives the air from land out to sea; but, its influence being removed, the air returns to fill up the former vacuity. Such is the usual method of accounting for this phenomenon; but, unfortunately, these sea and land breezes are visitants that come at all hours. On the coasts of Malabar, the land-breezes begin at midnight, and continue till noon; then the sea-breezes take their turn, and continue till midnight. While, again, at Congo, the land-breezes begin at five, and continue till nine the next day.

But, if the cause of these be so inscrutable, that we are as yet tolerably regular in their visitations, what shall we say to the winds of our own climate, that are continually shifting, and incapable of rest? Some general causes may be assigned, which nothing but particular experience can apply. And, in the first place, it may be observed, that clouds



and heat; and, in short, whatever either increases the density or the elasticity of the air, in any one place, will produce a wind there: for the increased activity of the air thus pressing more powerfully on the parts of it that are adjacent, will drive them forward; and thus go on, in a current, till the whole comes to an equality. Thus, upon a rise of air in one place, in this manner, as a denser air produces a wind, on the one hand, so will any accident, that contributes to lighten the air, produce it on the other: for a lighter air may be considered as a vacuum, into which the neighbouring air will rush: and hence it happens, that when the barometer marks a peculiar lightness in the air, it is no wonder that it foretells a storm. The winds upon large waters are generally more regular than those upon land. The wind at sea generally blows with an even steady gale; the wind at land puffs by intervals, increasing its strength, and remitting it, without any apparent cause. This, in a great measure, may be owing to the many mountains, towers, or trees, that it meets in its way, all contributing either to turn it from its course, or interrupt its passage. The east wind blows more constantly than any other, and for an obvious reason: all other winds are, in some measure, deviations from it, and partly may owe their origin thereto. It is generally, likewise, the most powerful, and for the same reason. There are often double currents of the air. While the wind blows one way, we frequently see the clouds move another. This is generally the case before thunder, for it is well known that the thunder cloud always moves against the wind. The cause of this surprising appearance has hitherto remained a secret. From hence we may conclude, that weathercocks only inform us of that current of the air, which is near the surface of the earth; but are often erroneous with regard to the upper regions; and, in fact, Bernoulli has often found them erroneous. Winds are generally more powerful in elevated situations than on the plain, because their progress is interrupted by fewer obstacles. In proportion as we ascend the heights of a mountain, the violence of the weather seems to increase, until we have got above the region of fogs, where all is usually calm and serene. Sometimes, however, the fogs rise even to the tops of the highest mountains; as we learn from those who have been on the Andes, and as we are convinced by the deep fogs that crown even the highest. Winds blowing from the sea are generally moister, and more attended with rains, than those which blow over extensive tracts of land: for the sea gives off more vapours to the air, and there are rolled forward upon land, by the winds blowing from thence. For this reason our easterly winds, that blow from the ocean, are dry, compared with those that blow from the surface of the ocean, with which we are surrounded on every other quarter. In general the winds are more boisterous in spring and autumn, than at either season: for that being the time of high tides, the sea may communicate a part of its motions to the winds. The sun and moon, also, which themselves have a greater effect upon the waters, may also have some influence upon the winds: for, there being a great body of air surrounding the globe, which, if condensed into water, would cover it to the depth of thirty-two feet, it is evident that the sun and moon will, to a proportionable degree, affect the atmosphere, and make a tide of air. This tide will be least perceptible, indeed, but without doubt, it actually exists; and may contribute to increase the vehemence

and autumnal storms, which are then known to prevail. Upon narrowing the passage through which the air is driven, both the density and the swiftness of the wind is increased. For as currents of water flow with greater force and rapidity by narrowing their channels, so also will a current of air, driven through a contracted space, grow more violent and irresistible. Hence we find those dreadful storms that prevail in the defiles of mountains, where the wind, pushing from behind through a narrow channel, at once increases in speed and density, levelling, or tearing up, every obstacle that rises to obstruct its passage. Winds reflected from the sides of mountains and towers are often found to be more forceful than those in direct progression. This we frequently perceive near lofty buildings, such as churches or steeples, where winds are generally known to prevail, and that much more powerful than at some distance. The air, in this case, by striking against the side of the building, acquires additional density, and therefore blows with more force. These differing degrees of density, which the air is found to possess, sufficiently shew that the force of the winds do not depend upon their velocity alone, but that those instruments called anemometers, which are made to measure the velocity of the wind, will by no means give us certain information of the force of the storm. In order to estimate this with exactness, we ought to know its density, which also these are not calculated to discover. For this reason we often see storms, with very powerful effects, that do not seem to have any great speed; and on the contrary, we see thick wind measurers go round, with great swiftness, when scarce any damage has followed from the storm. Such is the nature, and the inconsistency of the irregular winds with which we are best acquainted. But their effects are much more formidable in those climates, near the tropics, where they are often found to break in upon the steady course of the trade winds, and to mark their passage with destruction. With us the tempest is scarcely known, and its ravages are registered as an uncommon calamity; but, in the countries that lie between the tropics, and for a good space beyond them, its violence is frequent, and its effects anticipated. In these regions the winds vary their efforts, sometimes involving all things in suffocating heats, sometimes mixing all the elements of fire, air, earth, and water together; sometimes, with a more insidious violence, passing over the face of the country, and destroying all things in their passage, and sometimes raising whole sandy deserts in one country, to deposit them upon some other. We have little reason, therefore, to envy these climates the liberality of their soil, or the brightness of their skies. Our own muddy atmosphere, that wraps us round in obscurity, though it fails to gladden our prospects with sunshine, or our groves with fragrance, nevertheless answers the calls of industry. They may boast of a plentiful, but precarious harvest; while, with us, the labourer toils in a certain expectation of a moderate, but in happy return to Egypt, a kingdom is noted for its fertility, and the brightness of its atmosphere; during summer, the south winds are so hot, that they almost stop respiration; besides which, they are charged with such quantities of sand, that they sometimes darken the air, as with a thick cloud. These sands are so fine, and driven with such violence, that they penetrate every where; even into chests, be they shut never so closely. If these winds happen to continue for any length of time, they produce epidemic diseases, and are often followed by great mortality.



mortality. It is also found to rain but very seldom in that country; however, the want of showers is richly compensated by the copiousness of their dews, which greatly tend to promote vegetation.

In Persia, the winter begins in November, and continues till March. The cold at that time is intense enough to congeal the water; and snow falls in abundance upon their mountains. During the months of March and April, winds arise, that blow with great force, and seem to usher in the heats of summer. These return again, in autumn, with some violence; without, however, producing any dreadful effects. But, during their summer, all along the coasts of the Persian Gulph, a very dangerous wind prevails, which the natives call the *Sameel*, still more dreadful and burning than that of Egypt, and attended with instant and fatal effects. This terrible blast, which was, perhaps, the pestilence of the ancients, instantly kills all those that it involves in its passage. What its malignity consists in, none can tell, as none have ever survived its effects, to give information. It frequently assumes a visible form; and darts, in a kind of bluish vapour, along the surface of the country. The natives not only of Persia, but Arabia, talk of its effects with terror; and their poets have not failed to heighten them, with the assistance of imagination. They have described it as under the conduct of a minister of vengeance, who governs its terrors, and raises, or depresses it, as he thinks proper. These deadly winds are also known along the coasts of India, at Necapatan, Masulipatan, and Perapoli. But, luckily for mankind, the shortness of their duration diminishes the injuries that might ensue from their malignity.

The Cape of Good Hope, as well as many islands in the West-Indies, are famous for their hurricanes, and that extraordinary kind of cloud, which is said to produce them. This cloud, which is the forerunner of an approaching hurricane, appears, when first seen, like a small black spot on the verge of the horizon; and is called, by sailors, the bull's eye, from being seen so minute at a vast distance. All this time, a perfect calm reigns over the sea and land, while the cloud grows gradually broader as it approaches. At length, coming to the place where its fury is to fall, it invests the whole horizon with darkness. During all the time of its approach, an hollow murmur is heard in the cavities of the mountains; and beasts and animals, sensible of its approach, are seen running over the fields, to seek for shelter. Nothing can be more terrible than its violence when it begins. The houses in those countries, which are made of timber, the better to resist its fury, bend to the blast like osiers, and again recover their rectitude. The sun, which, but a moment before, blazed with meridian splendor, is totally shut out; and a midnight darkness prevails, except that the air is incessantly illuminated with gleams of lightning, by which one can easily see to read. The rain falls, at the same time, in torrents; and its descent has been resembled to what pours from the spouts of our houses after a violent shower. These hurricanes are not less offensive to the sense of smelling also; and never come without leaving the most noisome stench behind them. If the seamen also lay by their wet cloaths, for twenty-four hours, they are all found swarming with little white maggots, that were brought with the hurricane. Our first mariners, when they visited those regions, were ignorant of its effects, and the signs of its approach; their ships, therefore, were dashed to the bottom at the first onset; and numberless were the wrecks which the hurricane occasioned. But, at present, being forewarned of its approach, they strip their masts of all their sails, and thus patiently abide its fury. These hurricanes are com-

mon in all the tropical climates. On the coasts of Guinea they have frequently three or four in a day, that thus shut out the heavens for a little space; and when past leave all again in former splendor. They chiefly prevail, on that coast, in the intervals of the trade-winds; the approach of which clears the air of its meteors, and gives these mortal showers that little degree of wholesomeness, which they possess. They chiefly obtain there during the months of April and May; they are known at Loango, from January to April; on the opposite coast of Africa, the hurricane season begins at May; and, in general, whenever a trade-wind begins to cease, these irregular tempests are found to exert their fury.

All this is terrible; but there is a tempest, known in those climates, more formidable than any we have hitherto been describing, which is called, by the Spaniards, a *Tornado*. As the former was seen arriving from one part of the heavens, and making a line of destruction; so the winds in this seem to blow from every quarter, and settle upon one destined place, with such fury, that nothing can resist their vehemence. When they have all met, in their central spot, then the whirlwind begins with circular rapidity. The sphere every moment widens as it continues to turn, and catches every object that lies within its attraction. This, also, like the former, is preceded by a flattering calm; the air is every where hushed; and the sea is as smooth as polished glass: however, as its effects are more dreadful than those of the ordinary hurricane, the mariner tries all the power of his skill to avoid it; which, if he fails of doing, there is the greatest danger of his going to the bottom. All along the coasts of Guinea, beginning about two degrees north of the line, and so downward, lengthwise, for about a thousand miles, and as many broad, the ocean is unnavigable, upon account of these tornados. In this torpid region there reigns unceasing tornados, or continual calms; among which, whatever ship is so unhappy as to fall, is totally deprived of all power of escaping. In this dreadful repose of all the elements, the solitary vessel is obliged to continue, without a single breeze to assist the mariner's wishes, except those whirlwinds, which only serve to increase his calamity. At present, therefore, this part of the ocean is totally avoided; and, although there may be much gold along the coasts of that part of Africa, to tempt avarice, yet there is something, much more dreadful than the fabled dragon of antiquity, to guard the treasure. As the internal parts of that country are totally unknown to travellers, from their burning sand and extensive deserts, so here we find a vast tract of ocean, lying off its shores, equally unvisited by the mariner.

But of all these terrible tempests that deform the face of Nature, and repress human presumption, the sandy tempests of Arabia and Africa, are the most terrible, and strike the imagination most strongly. To conceive a proper idea of these, we are by no means to suppose them resembling those whirlwinds of dust that we sometimes see scattering in our air, and sprinkling their contents upon our roads or meadows. The sand-storm of Africa exhibits a very different appearance. As the sand of which the whirlwind is composed is excessively fine, and almost resembles the parts of water, its motion, entirely resembles that of a fluid; and the whole plain seems to float onward, like a slow inundation. The body of sand thus rolling, is deep enough to bury houses and palaces in its bosom; travellers who are crossing those extensive deserts, perceive its approach at a distance; and, in general, have time to avoid it, or turn out of its way, as it generally extends but to a moderate breadth. However,



ever, when it is extremely rapid, or very extensive, as sometimes is the case, no swiftness, no art, can avail; nothing then remains, but to meet death with fortitude, and submit to be buried alive with resignation.

It is happy for us of Britain, that we have no such calamity to fear; for, from this, even some parts of Europe are not entirely free. We have an account given us, in the History of the French Academy, of a miserable town in France, that is constantly in danger of being buried under a similar inundation. "In the neighbourhood of St. Paul de Leon, in Lower Brittany, there lies a tract of country along the sea-side, which before the year 1666 was inhabited, but now lies deserted, by reason of the sands which cover it, to the height of twenty feet; and which every year advance more and more in-land, and gain ground continually. From the time mentioned above, the sand has buried more than six leagues of the country inward; and it is now but half a league from the town of St. Paul; so that, in all appearance, the inhabitants must be obliged to abandon it entirely. In the country that has been overwhelmed, there are still to be seen the tops of some steeples peeping through the sand, and many chimnies that still remain above this sandy ocean. The inhabitants, however, had sufficient time to escape; but being deprived of their little all, they had no other resource but begging for their subsistence. This calamity chiefly owes its advancement to a north, or an east wind, raising the sand, which is extremely fine, in such great quantities, and with such velocity, that M. Deslandes, who gave the account, says, that while he was walking near the place, during a moderate breeze of wind, he was obliged, from time to time, to shake the sand from his cloaths and hat, on which it was lodged in great quantities, and made them too heavy to be easily borne. Still further, when the wind was violent, it drove the sand across a little arm of the sea, into the town of Roscoff, and covered the streets of that place two feet deep; so that they have been obliged to carry it off in carts. It may also be observed, that there are several particles of iron mixed with the sand, which are readily affected by the loadstone. The part of the coast that furnishes these sands, is a tract of about four leagues in length; and is upon a level with the sea at high-water. The shore lies in such a manner as to leave its sands subject only to the north and east winds, that bear them farther up the shore. It is easy to conceive how the same sand that has at one time been borne a short way in land, may, by some succeeding and stronger blast, be carried up much higher; and thus the whole may continue advancing forward, deluging the plain, and totally destroying its fertility. At the same time, the sea, from whence this deluge of sand proceeds, may furnish it in inexhaustible quantities. This unhappy country, thus overwhelmed in so singular a manner, may well justify what the antients and the moderns have reported concerning those tempests of sand in Africa, that are said to destroy villages, and even armies in their bosom."

#### C H A P. XXI.

OF METEORS, and such Appearances as result from a Combination of the Elements.

**I**N proportion as the substances of nature are more compounded and combined, their appearances become more inexplicable and amazing. The properties of water have been very nearly ascertained. Many of the qualities of air, earth, and fire, have been discovered, and estimated; but when these come to be united by Nature, they often

produce a result which no artificial combinations can imitate: and we stand surprised, that although we are possessed of all those substances which Nature makes use of, she shews herself a much more various operator than the most skilful chemist ever appeared to be. Every cloud that moves, and every shower that falls, serves to mortify the philosopher's pride; and to shew him hidden qualities in air and water, that he finds it difficult to explain. Dews, hail, snow, and thunder, are not less difficult for being more common. Indeed, when we reflect on the manner in which Nature performs any one of these operations, our wonder increases. To see water, which is heavier than air, rising in air, and then falling in a form so very different from that in which it rose; to see the same fluid at one time descending in the form of hail, at another in that of snow; to see two clouds, by dashing against each other, producing an electrical fire, which no watery composition that we know of can effect—these serve sufficiently to excite our wonder; and still the more, in proportion as the objects are ever pressing on our curiosity. Much, however, has been written concerning the manner in which nature operates in these productions; as nothing is so ungrateful to mankind as hopeless ignorance.

And first, with regard to the manner in which water evaporates, and rises to form clouds, much has been advanced, and many theories devised. All water, say some, has a quantity of air mixed with it; and the heat of the sun darting down, disengages the particles of this air from the grosser fluid: the sun's rays being reflected back from the water, carry back with them those bubbles of air and water which, being lighter than the condensed air, will ascend till they meet with a more rarefied air; and they will then stand suspended. Experience, however, proves nothing of all this. Particles of air or fire, are not thus known to ascend with a thin coat of water; and, in fact, we know that the little particles of steam are solid drops of water. But besides this, water is known to evaporate more powerfully in the severest frost, than when the air is moderately warm. Doctor Hamilton, therefore, of the university of Dublin, rejecting this theory, has endeavoured to establish another. According to him, as aqua fortis is a menstruum that dissolves iron, and keeps it mixed in the fluid; as aqua regia is a menstruum that dissolves gold; or as water dissolves salts to a certain quantity; so air is a menstruum that corrodes and dissolves a certain quantity of water, and keeps it suspended above. But however ingenious this may be, it can hardly be admitted; as we know, by Mariotte's experiment, that if water and air be enclosed together, instead of the air's acting as a menstruum upon the water, the water will act as a menstruum upon the air, and take it all up. We know also, that of two bodies, that which is most fluid and penetrating, is most likely to be the menstruum of the other; but water is more fluid and penetrating than air, and, therefore, the most likely of the two to be the menstruum. We know that all bodies are more speedily acted upon, the more their parts are brought into contact with the menstruum that dissolves them: but water, inclosed with compressed air, is not the more diminished thereby. In short, we know, that cold, which diminishes the force of other menstrooms, is often found to promote evaporation. In this variety of opinion, and uncertainty of conjecture, we cannot avoid thinking that a theory of evaporation may be formed upon very simple and obvious principles, and embarrassed with very few objections.

We know that a repelling power prevails in nature, not less than an attractive one. This repulsion prevails strongly between the body of fire and that



that of water. If the end of a red hot bar of iron be plunged into a vessel of water, the fluid rises, and large drops of it fly up in all manner of directions, every part bubbling and steaming until the iron be cold. Why may we not, for a moment, compare the rays of the sun, darted directly upon the surface of the water, to so many bars of red hot iron; each bar, indeed, infinitely small; but not the less powerful? In this case, wherever a ray of fire darts, the water, from its repulsive quality, will be driven on all sides; and, of consequence, as in the case of the bar of iron, a part of it will rise. The parts thus rising, however, will be extremely small; as the ray that darts is extremely so. The assemblage of the rays darting upon the water in this manner, will cause it to rise in a light thin steam above the surface; and as the parts of this steam are extremely minute, they will be lighter than air, and, consequently, float upon it. There is no need for supposing them bubbles of water, filled with fire; for any substance, even gold itself, will float on air, if its parts be made small enough; or, in other words, if its surface be sufficiently increased. This water, thus disengaged from the general mass, will be still farther attenuated and broken by the reflected rays, and consequently more adapted for ascending.

From this plain account, every appearance in evaporation may be easily deduced. The quantity of heat increases evaporation, because it raises a greater quantity of steam. The quantity of wind increases evaporation; for, by waving the surface of the water, it thus exposes a greater surface to the evaporating rays. A dry frost, in some measure, assists the quantity of evaporation; as the quantity of rays are found to be no way diminished thereby. Moist weather alone prevents evaporation; for the rays being absorbed, refracted, and broken, by the intervening moisture, before they arrive at the surface, cannot produce the effect; and the vapour will rise in a small proportion.

Thus far we have accounted for the ascent of vapours; but to account for their falling again, is attended with rather more difficulty. We have already observed, that the particles of vapour, disengaged from the surface of the water, will be broken and attenuated in their ascent, by the reflected, and even the direct rays, that happen to strike upon their minute surfaces. They will, therefore, continue to ascend, till they rise above the operation of the reflected rays, which reaches but to a certain height above the surface of the earth. Being arrived at this region, which is cold for want of reflected heat, they will be condensed, and suspended in the form of clouds. Some vapours that ascend to great heights, will be frozen into snow; others, that are condensed lower down, will put on the appearance of a mist, which we find the clouds to be, when we ascend among them, as they hang along the sides of a mountain. These clouds of snow and rain, being blown about by winds, are either entirely scattered and dispersed above, or they are still more condensed by motion, like a snow-ball, that grows more large and solid as it continues to roll. At last, therefore, they will become too weighty for the air which first raised them, to sustain; and they will descend, with their excess of weight, either in snow or rain. But as they will fall precipitately, when they begin to descend, the air, in some measure, will resist the falling; for, as the descending fluid gathers velocity in its precipitation, the air will increase its resistance to it, and the water will, therefore, be thus broken into rain; as we see, that water which falls from the tops of houses, though it begins in a spout, separates into drops before it has got to the bottom. Were it not for this happy interposition of the air, between us

and the water falling from a considerable height above us, a drop of rain might fall with dangerous force, and an hail-stone might strike us with fatal rapidity.

In this manner, evaporation is produced by day; but when the sun goes down, a part of that vapour which his rays had excited, being no longer broken; and attenuated by the reflecting rays, it will become heavier than the air, even before it has reached the clouds; and it will, therefore, fall back in dews, which differ only from rain in descending before they have had time to condense into a visible form.

Hail, the Cartesians say, is a frozen cloud, half melted, and frozen again in its descent. An hoar-frost is but a frozen dew. Lightning we know to be an electrical flash, produced by the opposition of two clouds: and thunder to be the sound proceeding from the same; continued by an echo reverberated among them. It would be to very little purpose, to attempt explaining exactly how these wonders are effected: we have as yet but little insight into the manner in which these meteors are found to operate upon each other; and, therefore, we must be contented with a detail rather of their effects than their causes.

In our own gentle climate, where Nature wears the mildest and kindest aspect, every meteor seems to befriend us. With us, rains fall in refreshing showers, to enliven our fields, and to paint the landscape with a more vivid beauty. Snows cover the earth, to preserve its tender vegetables from the inclemency of the departing winter. The dews descend with such an imperceptible fall as no way injures the constitution. Even thunder is seldom injurious; and it is often wished by the husbandman, to clear the air, and to kill numberless insects that are noxious to vegetation. Hail is the most injurious meteor that is known in our climate; but it seldom visits us with violence, and then its fury is but transient.

One of the most dreadful storms we hear of, was that of Hertfordshire, in the year 1697. It began by thunder and lightning, which continued for some hours, when suddenly a black cloud came forward, against the wind, and marked its passage with devastation. The hail-stones which it poured down, being measured, were found to be many of them fourteen inches round, consequently, as large a bowling-green ball. Wherever it came, every plantation fell before it; it tore up the ground, split great oaks, and other trees, without number; the fields of rye were cut down, as if levelled with a scythe; wheat, oats, and barley, suffered the same damage. The inhabitants found but a precarious shelter, even in their houses, their tiles and windows being broke by the violence of the hail-stones, which, by the force with which they came, seemed to have descended from a great height. The birds, in this universal wreck, vainly tried to escape by flight; pigeons, crows, rooks, and many more of the smaller and feebler kinds, were brought down. An unhappy young man, who had not time to take shelter, was killed; one of his eyes was struck out of his head, and his body was all over black with the bruises: another had just time to escape, but not without the most imminent danger, his body being bruised all over. But what is most extraordinary, all this fell within the compass of a mile.

Mezeray, in his History of France, tells us of a shower of hail much more terrible, which happened in the year 1510, when the French monarch invaded Italy. There was, for a time, an horrid darkness, thicker than that of midnight, which continued till the terrors of mankind were changed to still more terrible objects, by thunder and lightning breaking the gloom, and bringing on such a shower of hail, as no history of human calamities could



could equal. These hail-stones were of a bluish colour; and some of them weighed not less than an hundred pounds. A noisome vapour of sulphur attended the storm. All the birds and beasts of the country were entirely destroyed. Numbers of the human race suffered the same fate. But what is still more extraordinary, the fishes found no protection from their native element; but were equal sufferers in the general calamity.

These, however, are terrors that are seldom exerted in our mild climates. They only serve to mark the page of history with wonder; and stand as admonitions to mankind, of the various stores of punishment in the hands of the Deity, which his power can treasure up, and his mercy can suspend. In the temperate zones, therefore, meteors are rarely found thus terrible; but between the tropic, and near the poles, they assume very dreadful and various appearances. In those inclement regions, where cold and heat exert their chief power, meteors seem peculiarly to have fixed their residence. They are seen there in a thousand terrifying forms, astonishing to Europeans, yet disregarded by the natives, from their frequency. The wonders of air, fire, and water, are there combined, to produce the most tremendous effects; and to sport with the labours and apprehensions of mankind. Lightnings, that flash without noise; hurricanes, that tear up the earth; clouds, that all at once pour down their contents, and produce an instant deluge; mock suns, northern lights, that illuminate half the hemisphere; circular rainbows; halos; fleeting balls of fire; clouds, reflecting back the images of things on earth, like mirrors; and water-spouts, that burst from the sea, to join with the mists, that hang immediately above them. These are but a part of the phænomena that are common in those countries; and from many of which, our own climate is, in a great measure, exempted.

The meteors of the torrid zone are different from those that are found near the polar circles: and it may readily be supposed, that in those countries where the sun exerts the greatest force in raising vapours of all kinds, there should be the greatest quantity of meteors. Upon the approach of the winter months, as they are called, under the line, which usually begin about May, the sky, from a fiery brightness, begins to be overcast, and the whole horizon seems wrapt in a muddy cloud. Mists and vapours still continue to rise; and the air, which so lately before was clear and elastic, now becomes humid, obscure, and stifling: the fogs become so thick, that the light of the sun seems in a manner excluded; nor would its presence be known, but for the intense and suffocating heat of its beams, which dart through the gloom, and, instead of dissipating, only serve to increase the mist. After this preparation, there follows an almost continual succession of thunder, rain, and tempests. During this dreadful season, the streets of cities flow like rivers; and the whole country wears the appearance of an ocean. The inhabitants often make use of this opportunity to lay in a stock of fresh water, for the rest of the year; as the same cause which pours down the deluge at one season, denies the kindly shower at another. The thunder which attends the fall of these rains, is much more terrible than that we are generally acquainted with. With us, the flash is seen at some distance, and the noise shortly after ensues; our thunder generally rolls on one quarter of the sky, and one stroke pursues another. But here it is otherwise; the whole sky seems illuminated with unremitted flashes of lightning; every part of the air seems productive of its own thunders; and every cloud produces its own shock. The strokes come so thick, that the inhabitants can scarce mark the intervals; but all is one unremitted roar of elementary

confusion. It should seem, however, that the lightning of those countries is not so fatal, or so dangerous, as with us; since, in this case, the torrid zone would be uninhabitable.

When these terrors have ceased, with which, however, the natives are familiar, meteors of another kind begin to make their appearance. The intense beams of the sun, darting upon stagnant waters, that generally cover the surface of the country, raise vapours of various kinds. Floating bodies of fire, which assume different names, rather from their accidental forms, than from any real difference between them, are seen without surprise. The draco volans, or flying dragon, as it is called; the ignis fatuus, or wandering fire; the fires of St. Helmo, or the mariner's light, are every where frequent; and of these we have numberless descriptions. "As I was riding in Jamaica," says Mr. Barham, "one morning from my habitation, situated about three miles north-west from Jago de la Vega, I saw a ball of fire, appearing to me of the bigness of a bomb, swiftly falling down with a great blaze. At first I thought it fell into the town; but when I came nearer, I saw many people gathered together, a little to the southward, in the Savannah, to whom I rode up, to enquire the cause of their meeting: they were admiring, as I found, the ground's being strangely broke up and ploughed by a ball of fire; which, as they said, fell down there. I observed there were many holes in the ground; one in the middle of the bigness of a man's head, and five or six smaller round about it, of the bigness of one's fist, and so deep as not to be fathomed by such implements as were at hand. It was observed, also, that all the green herbage was burnt up, near the holes; and there continued a strong smell of sulphur near the place, for some time after."

Ulloa gives an account of one of a similar kind, at Quito. "About nine at night," says he, "a globe of fire appeared to rise from the side of the mountain Pichinca, and so large, that it spread a light over all the part of the city facing that mountain. The house where I lodged looking that way, I was surprised with an extraordinary light, darting through the crevices of the window-shutters. On this appearance, and the bustle of the people in the street, I hastened to the window, and came time enough to see it, in the middle of its career; which continued from west to south, till I lost sight of it, being intercepted by a mountain, that lay between me and it. It was round; and its apparent diameter about a foot. I observed it to rise from the sides of Pichinca; although, to judge from its course, it was behind that mountain where this congeries of inflammable matter was kindled. In the first half of its visible course it emitted a prodigious effulgence, then it began gradually to grow dim; so that, upon its disappearing behind the intervening mountain, its light was very faint."

Meteors, of this kind, are very frequently seen between the tropics; but they sometimes, also, visit the more temperate regions of Europe. We have the description of a very extraordinary one, given us by Montanari, that serves to shew to what great heights, in our atmosphere, these vapours are found to ascend. In the year 1676, a great globe of fire was seen at Bononia, in Italy, about three-quarters of an hour after sun-set. It passed westward, with a most rapid course, and at the rate of not less than a hundred and sixty miles in a minute, which is much swifter than the force of a cannon-ball, and, at last, stood over the Adriatic sea. In its course it crossed over all Italy; and, by computation, it could not have been less than thirty-eight miles above the surface of the earth. In the whole line of its course, wherever it approached, the inhabitants below could distinctly hear it, with a hissing noise, resembling



resembling that of a fire-work. Having passed away to sea, towards Conica, it was heard, at last, to go off with a most violent explosion, much louder than that of a cannon; and, immediately after, another noise was heard, like the rattling of a great cart upon a stony pavement; which was, probably, nothing more than the echo of the former sound. Its magnitude, when at Bononia, appeared twice as long as the moon, one way; and as broad the other; so that, considering its height, it could not have been less than a mile long, and half a mile broad. From the height at which this was seen, and there being no volcano on that quarter of the world, from whence it came, it is more than probable that this terrible globe was kindled on some part of the contrary side of the globe, in those regions of vapours, which we have been just describing; and thus rising above the air, and passing in a course opposite to that of the earth's motion, in this manner it acquired its amazing rapidity.

To these meteors, common enough southward, we will add one more of a very uncommon kind, which was seen by Ulloa, at Quito, in Peru; the beauty of which will, in some measure, serve to relieve us, after the description of those hideous ones preceding. "At day-break," says he, "the whole mountain of Pambamarca, where we then resided, was encompassed with very thick clouds, which the rising of the sun dispersed so far, as to leave only some vapours, too fine to be seen. On the side opposite to the rising sun, and about ten fathoms distant from the place where we were standing, we saw, as in a looking glass, each his own image; the head being, as it were, the center of three circular rainbows, one without the other, and just near enough to each other as that the colours of the internal verged upon those more external; while round all was a circle of white, but with a greater space between. In this manner these circles were erected, like a mirror, before us; and as we moved, they moved, in disposition and order. But, what is most remarkable, though we were six in number, every one saw the phenomenon, with regard to himself, and not that relating to others. The diameter of the arches gradually altered, as the sun rose above the horizon; and the whole, after continuing a long time insensibly faded away. In the beginning, the diameter of the inward iris, taken from its last colour, was about five degrees and a half; and that of the white arch, which surrounded the rest, was not less than sixty-seven degrees. At the beginning of the phenomenon, the arches seemed of an oval or elliptical figure, like the disk of the sun; and afterwards became perfectly circular. Each of these was of a red colour, bordered with an orange; and the last bordered by a bright yellow, which altered into a straw colour, and this turned to a green; but, in all, the external colour remained red." Such is the description of one of the most beautiful illusions that has been ever seen in nature. This alone seems to have combined all the splendours of optics in one view. To understand the manner, therefore, how this phenomenon was produced, would require a perfect knowledge of optics; which it is not our present province to enter upon. It will be sufficient, therefore, only to observe, that all these appearances arise from the density of the cloud, together with its uncommon and peculiar situation, with respect to the spectator and the sun. It may be observed, that but one of these three rainbows was real, the rest being only reflections thereof. It may also be observed, that whenever the spectator stands between the sun and a cloud of falling rain, a rainbow is seen, which is nothing more than the reflection of the different coloured rays of light from the bosom of the cloud. If, for instance, we

take a glass globe, filled with water, and hang it up before us, opposite the sun, in many situations, it will appear transparent; but if it is raised higher, or sideways, to an angle of forty-five degrees, it will at first appear red; altered a very little higher, yellow; then green, then blue, then violet colour; in short, it will assume successively all the colours of the rainbow; but, if raised higher, still it will become transparent again. A falling shower may be considered as an infinite number of these little transparent globes, assuming different colours, by being placed at the proper heights. The rest of the shower will appear transparent, and no part of it will seem coloured; but such as are at angles of forty-five degrees from the eye, forty-five degrees upward, forty-five degrees on each side, and forty-five degrees downward, did not the plain of the earth prevent us. We, therefore, see only an arch of the rainbow, the lower part being cut off from our sight by the earth's interposition. However, upon the tops of very high mountains, circular rainbows are seen, because we can see to an angle of forty-five degrees downward, as well as upward, or sideways, and therefore we take in the rainbow's complete circle.

In those forlorn regions, round the poles, the meteors though of another kind, are not less numerous and alarming. When the winter begins, and the cold prepares to set in, the same misty appearance which is produced in the southern climates by the heat, is there produced by the contrary extreme. The sea smokes like an oven, and a fog arises, which mariners call the frost smoke. This cutting mist, commonly raises blisters on several parts of the body; and, as soon as it is wasted to some colder part of the atmosphere, it freezes to little icy particles, which are driven by the wind, and create such an intense cold on land, that the limbs of the inhabitants are sometimes frozen, and drop off.

There also, halos, or luminous circles round the moon, are oftener seen than in any other part of the earth, being formed by the frost smoke; although the air otherwise seems to be clear. A lunar rainbow also is often seen there, though somewhat different from that which is common with us; as it appears of a pale white, striped with grey. In these countries also the aurora borealis streams, with peculiar lustre, and variety of colours. In Greenland it generally arises in the east, and darts its sportive fires, with variegated beauty, over the whole horizon. Its appearance is almost constant in winter; and, at those seasons when the sun departs, to return no more for half a year, this meteor kindly rises to supply its beams, and affords sufficient light for all the purposes of existence. However, in the very midst of their tedious night, the inhabitants are not entirely forsaken. The tops of the mountains are often seen painted with the red rays of the sun; and the poor Greenlander from thence begins to date his chronology. It would appear whimsical to read a Greenland calendar, in which we might be told, that one of their chiefs, having lived forty days, died, at last, of a good old age; and that his widow continued for half a day to deplore his loss, with great fidelity, before she admitted a second husband. The meteors of the day, in these countries, are not less extraordinary than those of the night: mock suns are often reflected upon an opposite cloud; and the ignorant spectator fancies that there are often three or four real suns in the firmament at the same time. In this splendid appearance the real sun is always readily known by its superior brightness, every reflection being seen with diminished splendour. The solar rainbow there is often seen different from ours. Instead of a pleasing variety of colours,



lours; it appears of a pale white, edged with a stripe of dusky yellow; the whole being reflected from the bosom of a frozen cloud.

But, of all the meteors which mock the imagination with an appearance of reality, those strange illusions that are seen there, in fine serene weather, are the most extraordinary and entertaining. "Nothing," says Krantz, "ever surprised me more, than, on a fine warm summer's day, to perceive the islands that lie four leagues west of our shore, putting on a form quite different from what they are known to have. As I stood gazing upon them, they appeared, at first, infinitely greater than what they naturally are; and seemed as if I viewed them through a large magnifying glass. They were not thus only made larger, but brought nearer to me. I plainly descried every stone upon the land, and all the furrows filled with ice, as if I stood close by. When this illusion had lasted for a while, the prospect seemed to break up, and a new scene of wonder to present itself. The islands seemed to travel to the shore, and represented a wood, or a tall cut hedge. The scene then shifted, and shewed the appearance of all sorts of curious figures; as ships with sails, streamers and flags; antique elevated castles, with decayed turrets; and a thousand forms, for which fancy found a resemblance in nature. When the eye had been satisfied with gazing, the whole groupe of riches seemed to rise in air, and at length vanish into nothing. At such times the weather is quite serene and clear; but compressed with such subtle vapours, as it is in very hot weather; and these appearing between the eye and the object, give it all that variety of appearances which glasses of different refrangibilities would have done." Mr. Krantz observes, that commonly a couple of hours afterwards, a gentle west wind and a visible mist follows, which puts an end to this *lufus nature*.

It were easy to swell this catalogue of meteors with the names of many others, both in our own climate and in other parts of the world. Such as falling stars, which are thought to be no more than unctuous vapours, raised from the earth to small heights, and continuing to shine till that matter which first raised and supported them, being burnt out, they fall back again to the earth, with extinguished flame. Burning spears, which are a peculiar kind of aurora borealis; bloody rains, which are said to be the excrements of an insect, that at that time has been raised into the air. Showers of stones, fishes, and ivy-berries, at first, no doubt, raised into the air by tempests in one country, and falling at some considerable distance, in the manner of rain, to astonish another. But omitting these, of which we know little more than what is thus briefly mentioned, we will give a description of a water-spout; a most surprising phenomenon; not less dreadful to mariners, than astonishing to the observers of nature.

These spouts are seen very commonly in the tropical seas, and sometimes in our own. Those seen by Tournefort, in the Mediterranean, he has described as follows. "The first of these," says this great botanist, "that we saw, was about a musket-shot from our ship. There we perceived the water began to boil, and to rise about a foot above its level. The water was agitated and whitish; and above its surface there seemed to stand a smoke, such as might be imagined to come from wet straw before it begins to blaze. It made a sort of a murmuring sound, like that of a torrent, heard at a distance, mixed, at the same time, with an hissing noise, like that of a serpent: shortly after we perceived a column of this smoke rise up to the clouds, at the same time whirling about with great rapidity. It appeared to be as thick as one's finger, and the

former sound still continued. When this disappeared, after lasting for about eight minutes, upon turning to the opposite quarter of the sky, we perceived another, which began in the manner of the former; presently after a third appeared in the west, and instantly beside it still another arose. The most distant of these three could not be above a musket-shot from the ship. They all continued like so many heaps of wet straw set on fire, that continued to smoke, and to make the same noise as before. We soon after perceived each, with its respective canal, mounting up in the clouds, and spreading where it touched; the cloud, like the mouth of a trumpet, making a figure, to express it intelligibly, as if the tail of an animal were pulled at one end by a weight. These canals were of a whitish colour, and so tinged, as I suppose, by the water which was contained in them; for, previous to this, they were apparently empty, and of the colour of transparent glass. These canals were not straight, but bent in some parts, and far from being perpendicular, but rising in their clouds with a very inclined ascent. But what is very particular, the cloud to which one of them was pointed happening to be driven by the wind, the spout still continued to follow its motion, without being broken; and passing behind one of the others, the spouts crossed each other, in the form of a St. Andrew's cross. In the beginning they were all about as thick as one's finger, except at the top, where they were broader, and two of them disappeared; but shortly after, the last of the three increased considerably; and its canal, which was at first so small, soon became as thick as a man's arm, then as his leg, and at last thicker than his whole body. We saw distinctly, through this transparent body, the water, which rose up with a kind of spiral motion; and it sometimes diminished a little of its thickness, and again resumed the same; sometimes widening at top, and sometimes at bottom; exactly resembling a gut filled with water, pressed with the fingers, to make the fluid rise or fall; and I am well convinced, that this alteration in the spout was caused by the wind, which pressed the cloud, and impelled it to give up its contents. After some time its bulk was so diminished as to be no thicker than a man's arm again; and thus, swelling and diminishing, it at last became very small. In the end, I observed the sea which was raised about it to resume its level by degrees, and the end of the canal that touched it to become as small as if it had been tied round with a cord; and this continued till the light, striking through the cloud, took away the view. I still, however, continued to look, expecting that its parts would join again, as I had before seen in one of the others, in which the spout was more than once broken, and yet again came together; but I was disappointed, for the spout appeared no more."

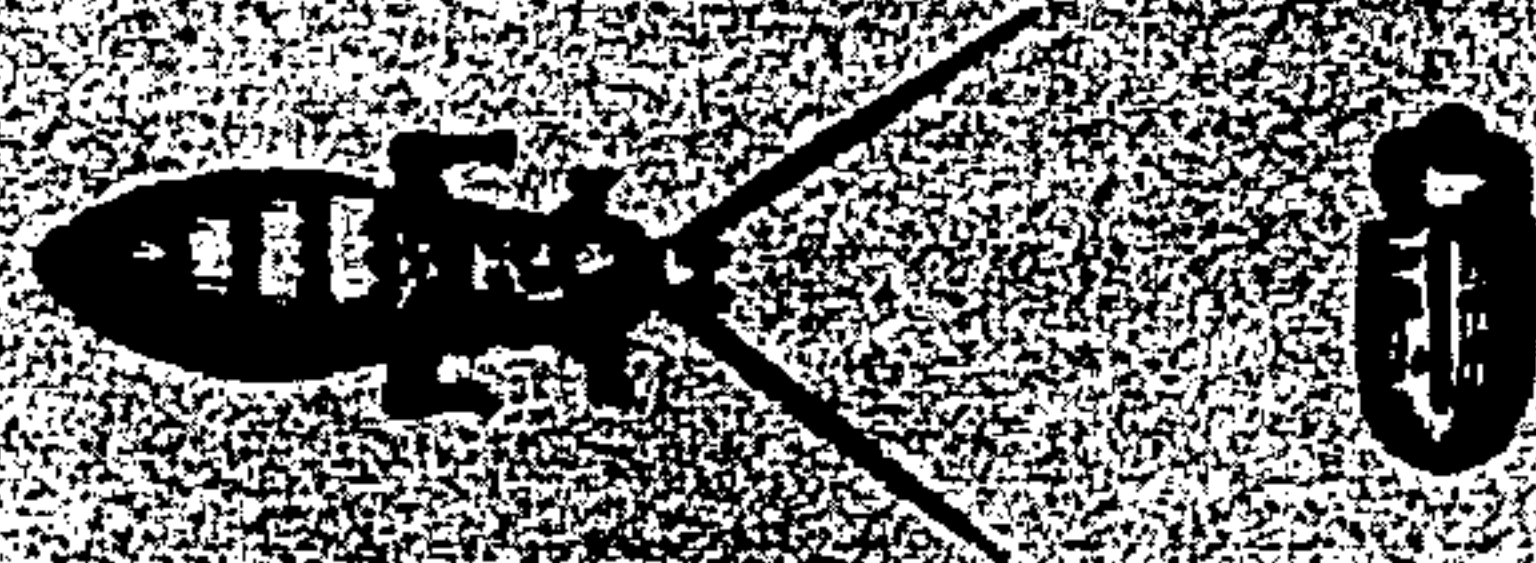
Many have been the solutions offered for this surprising appearance. Mr. Buffon supposes the spout, here described, to proceed from the operation of fire, beneath the bed of the sea; as the waters at the surface are thus seen agitated. However, the solution of Dr. Stuart is not divested of probability; who thinks it may be accounted for by suction, as in the application of a cupping-glass to the skin.

Wherever spouts of this kind are seen they are extremely dreaded by mariners; for if they happen to fall upon a ship they most commonly dash it to the bottom. But, if the ship be large enough to sustain the deluge, they are at least sure to destroy its sails and rigging, and render it unfit for sailing. It is said that vessels of any force usually fire their guns at them, loaden with a bar of iron; and, if so happy as to strike them, the water is instantly seen



VARIOUS OBJECTS IN NATURAL HISTORY.

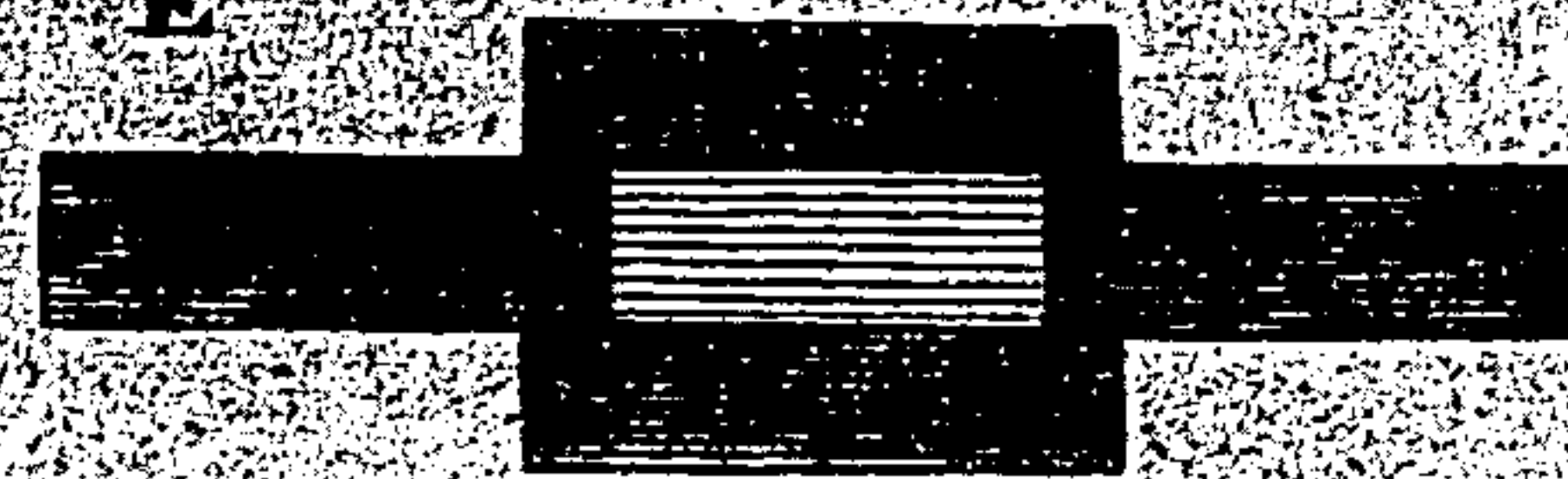
DEATH WATCH



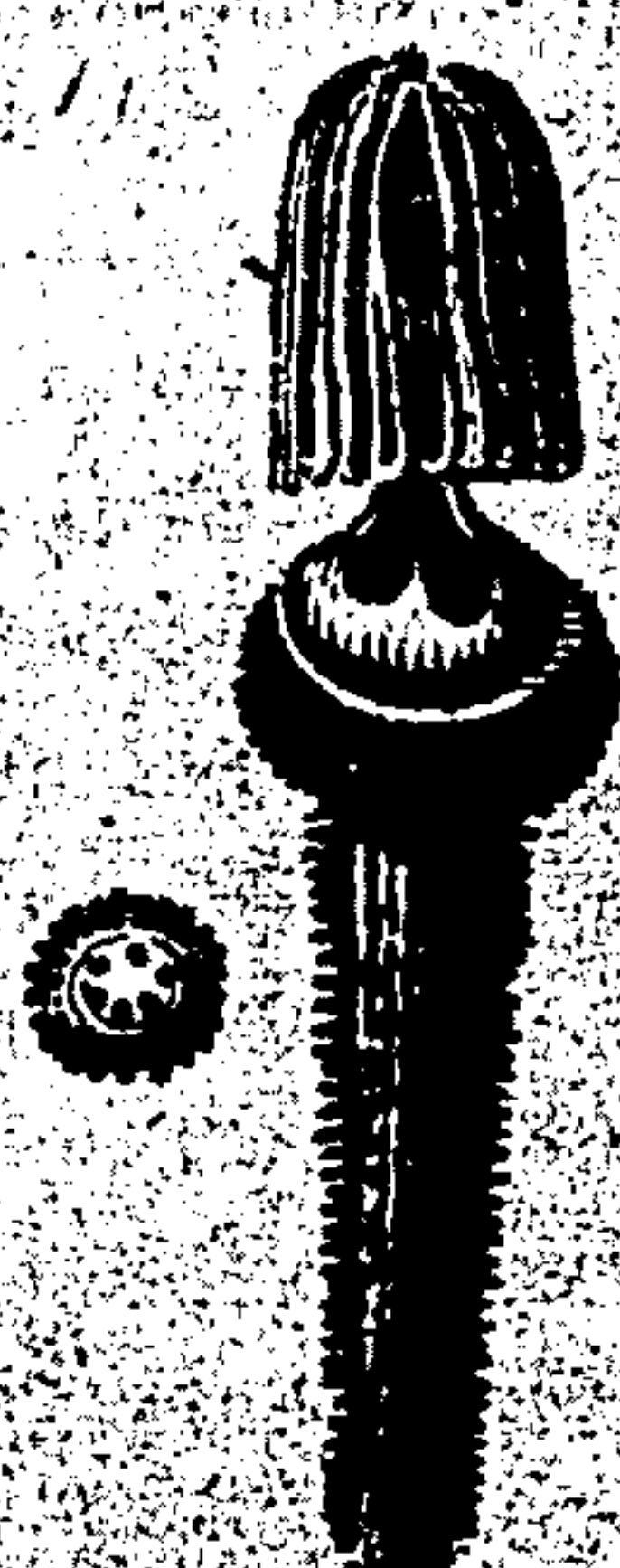
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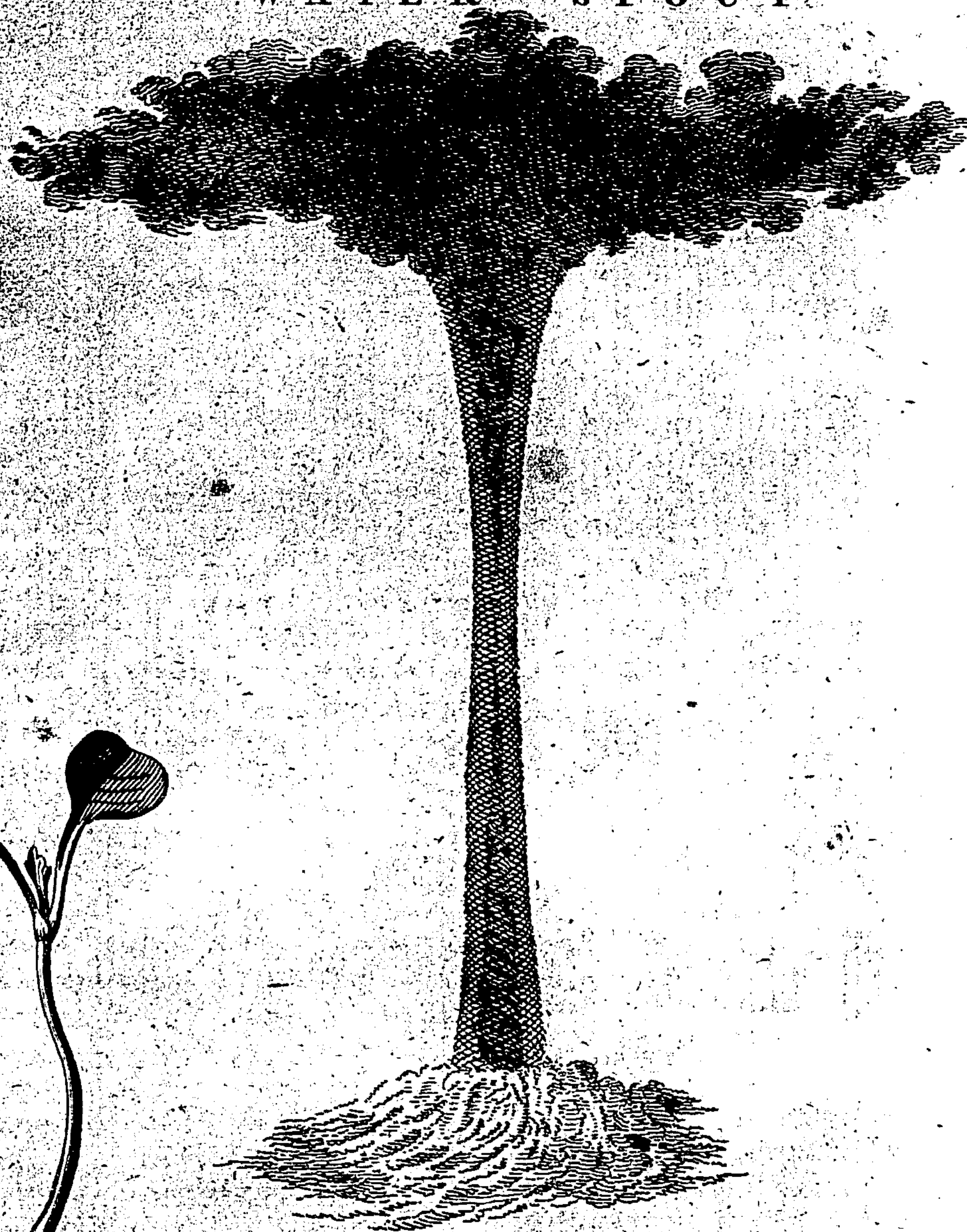
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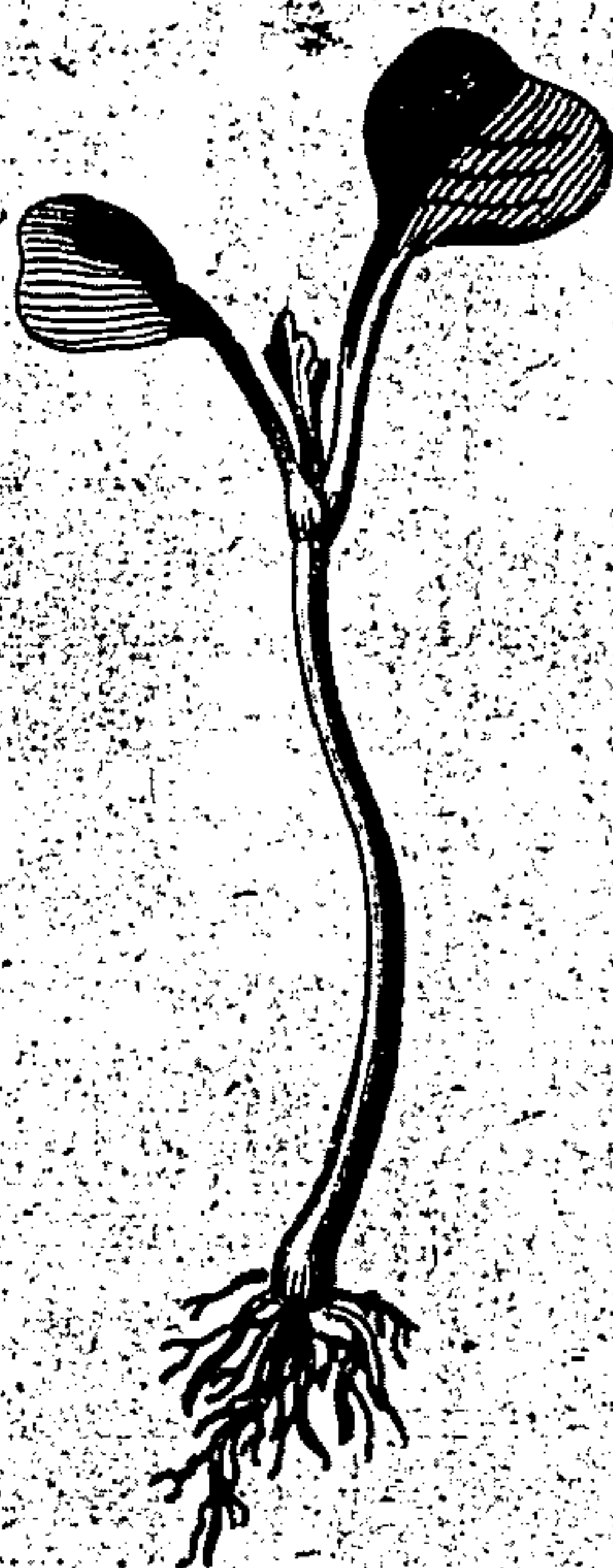
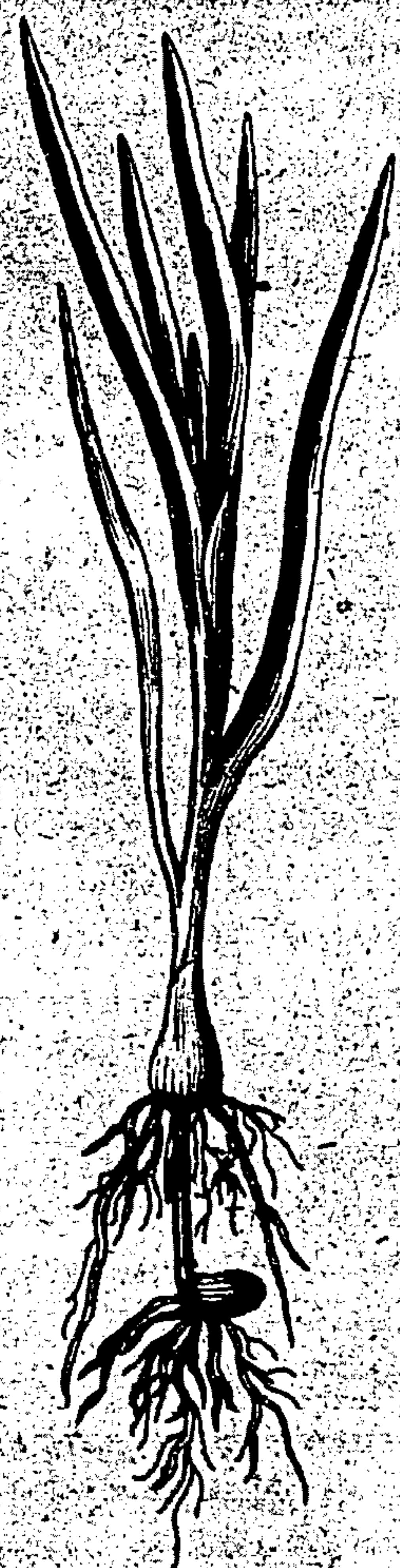
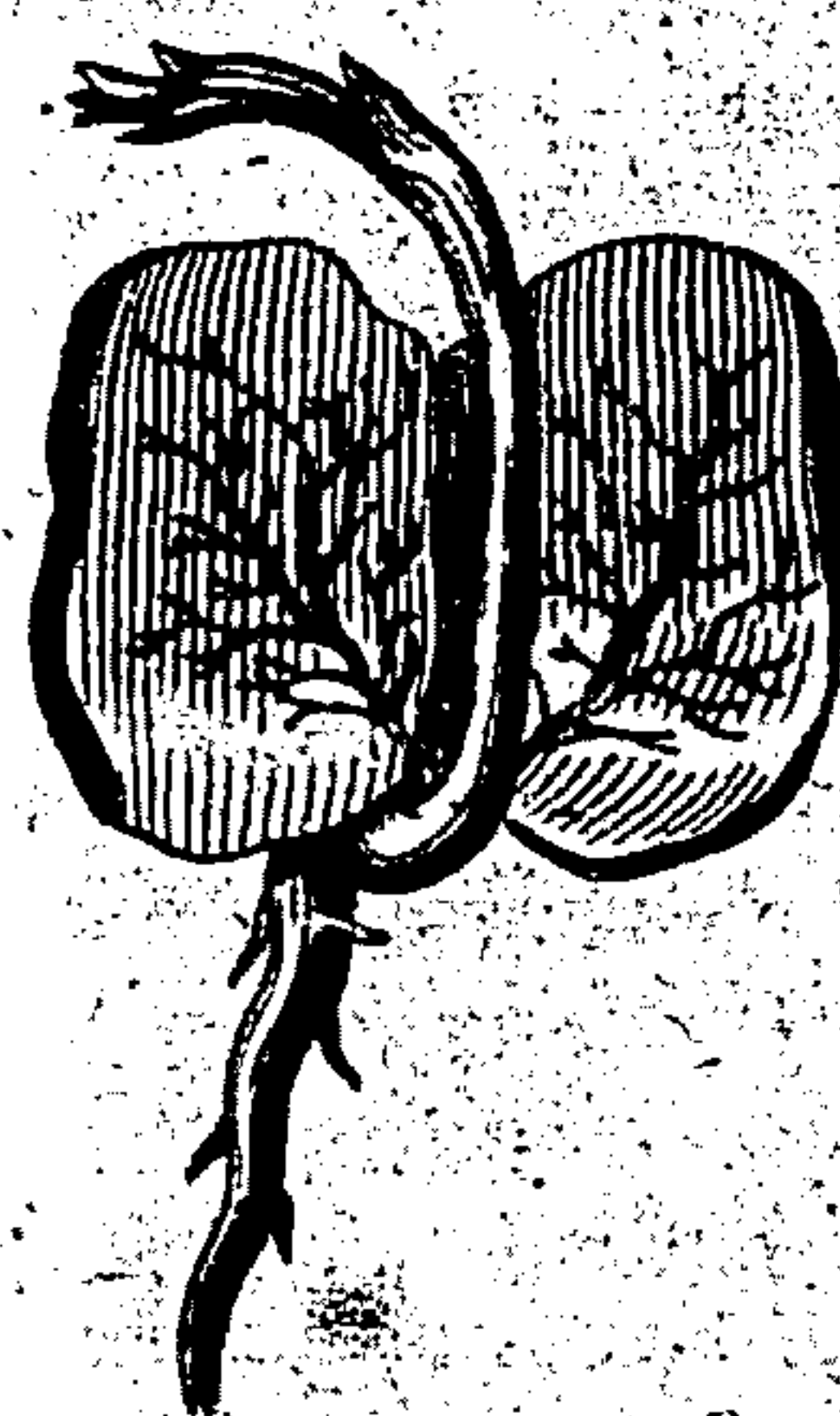
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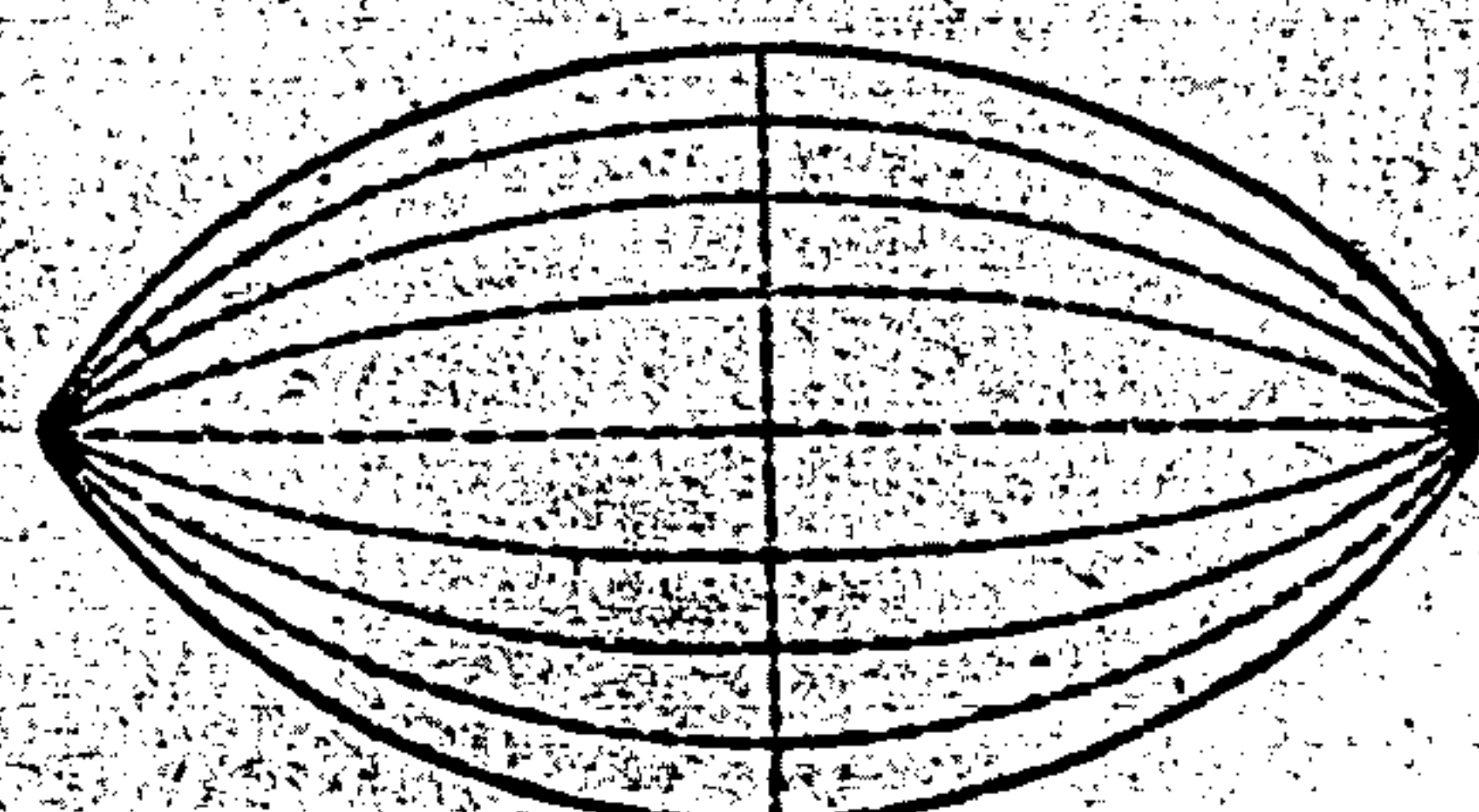
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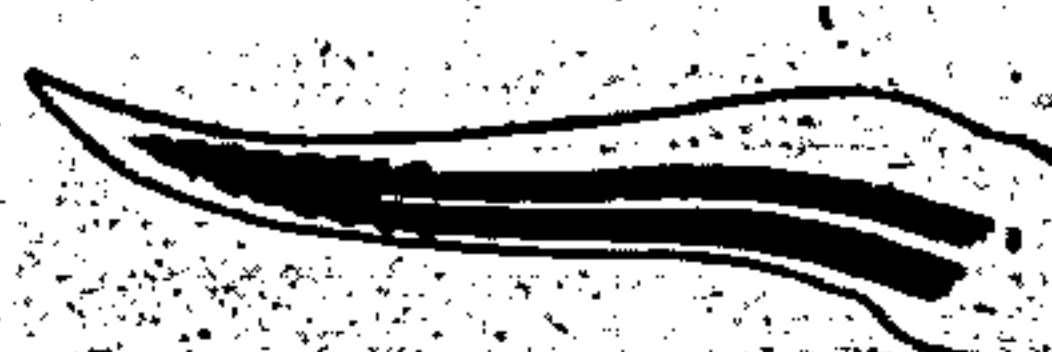
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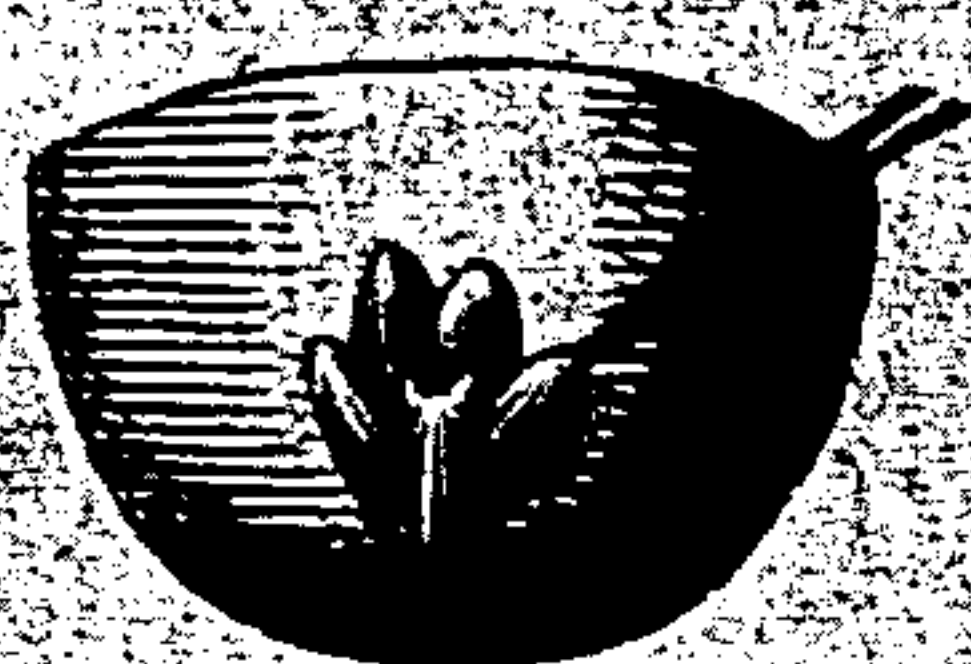
V O I C E



S T I N G



S P I D E R W E B S









to fall from them, with a dreadful noise, though without any further mischief.

The more the sky is obscured with clouds, water-spouts, and the phenomena which accompany them, are the more easily observed.

M. de la Nux thinks, and perhaps with reason, that water-spouts are nothing but viscous portions of a cloud driven off by different whirlwinds, i. e. by the whirlings of the superior air sinking into the mass of vapours of which the whole cloud is composed.

What seems to prove that these water-spouts are composed of viscous parts, is the tenaciousness of their cohesion; for they make inflexions and curvatures in every direction, without breaking. If the matter of water-spouts was not viscous, how can we conceive that they should, without breaking, bend and obey the motion of the winds? If all the parts did not firmly adhere, the wind would dissipate them; or, at least, make them change their form. But, as the form, both of the large and small water-spouts, is uniformly the same, this is almost a certain indication of the viscous tenacity of the matter of which they are composed.

Thus the basis of the matter of water-spouts is a viscous substance contained in the clouds, and every water-spout is formed by a whirlwind of air pressing through the mass of vapours, and, by blowing up the inferior part of the cloud, pierces it, and descends with its covering of viscous matter. And, as complete water-spouts descend from the cloud to the surface of the sea, the water must boil and whirl at the place to which the end of the water-spout is directed; because the air blows from the extremity of the water-spout like the tube of a pair of bellows. The effects of this blowing upon the sea will augment, in proportion as the cylinder approaches the surface of the water; and, when the orifice of the tube enlarges, a greater quantity of air is permitted to escape, and the agitation of the water is, of course, increased.

M. de la Nux has seen water-spouts around the isle of Bourbon in the months of January, May, June, and October, i. e. in all seasons of the year. He has seen them in calm weather, and during the highest winds. These phenomena, however, may be said to be rare, and seldom appear but upon the sea; because the viscosity of the clouds can only proceed from the bituminous and greasy particles raised, by the heat of the sun and the winds, from the waters of the sea, and collected in the clouds near its surface. It is for this reason that water-spouts seldom appear on land, where there is not, as on the surface of the sea, a sufficient quantity of bituminous and oily particles to be exhaled by the action of the sun. They are sometimes, however, observed on land, and even at great distances from the sea; this effect may be produced, when viscous clouds have been rapidly driven by a violent wind from the sea toward the land. M. Grignon, in the month of June 1768, saw a well formed water-spout in Lorrain near Vauvillier, among the hills which are a continuation of the Vosges. It was about fifty fathoms high. Its form was that of a column, and it communicated with a large thick cloud. It was impelled by one or several winds, which made the water-spout turn rapidly; and it produced lightning and thunder. This water-spout continued seven or eight minutes only, and broke upon the base of the hill, which is from five to six hundred feet high.

We are at a loss whether we ought to reckon these spouts called typhons, which are sometimes seen at land, of the same kind with those so often described by mariners, at sea, as they seem to differ in several respects. That, for instance, observed at Hatfield, in Yorkshire, in 1687, as it is described

by a person who saw it, seems rather to have been a whirlwind than a water-spout. The season in which it appeared was very dry, the weather extremely hot, and the air very cloudy. After the wind had blown for some time, with considerable force, and condensed the black clouds one upon another, a great whirling of the air ensued, upon which the center of the clouds, every now and then, darted down, in the shape of a thick long black pipe, in which the relator could distinctly view a motion, like that of a screw, continually screwing up to itself, as it were, whatever it happened to touch. In its progress it moved slowly over a grove of young trees, which it violently bent, in a circular motion. Going forward to a barn, it in a minute stripped it of all the thatch, and filled the whole air with the same. As it came near the relator, he perceived that its blackness proceeded from a gyration of the clouds, by contrary winds, meeting in a point, or a center; and where the greatest force was exerted, there darting down, like an Archimedes's screw, to suck up all that came in its way. Another which he saw, some time after, was attended with still more terrible effects; levelling, or tearing up great oak trees, catching up the birds in its vortex, and dashing them against the ground. In this manner it proceeded, with an audible whirling noise, like that of a mill; and, at length, dissolved, after having done much mischief.

But we must still continue to suspend our assent as to the nature even of these land spouts; since they have been sometimes found to drop, in a great column of water, at once upon the earth, and produce an instant inundation, which could not readily have happened had they been caused by the gyration of a whirlwind only. Indeed, every conjecture regarding these meteors, seems to be entirely unsatisfactory. They sometimes appear in the calmest weather at sea; and, therefore, these are not caused by a whirlwind. They are always capped by a cloud; and, therefore, are not likely to proceed from fires at the bottom. They change place; and, therefore, suction seems impracticable. In short, we still want facts, upon which to build a rational theory; and, instead of knowledge, we must be contented with admiration. To be well acquainted with the appearances of Nature, even though we are ignorant of their causes, often constitutes the most useful wisdom.

Having thus gone through a particular description of the earth, let us now pause for a moment, to contemplate the great picture before us. The universe may be considered as the palace in which the Deity resides; and this earth as one of its apartments. In this, all the meaner races of animated nature mechanically obey him; and stand ready to execute his commands, without hesitation. Man alone is found refractory; he is the only being endued with a power of contradicting these mandates. The Deity was pleased to exert superior power in creating him a superior being; a being endued with a choice of good and evil; and capable, in some measure, of co-operating with his own intentions. Man, therefore, may be considered as a limited creature, endued with powers imitative of those residing in the Deity. He is thrown into a world that stands in need of his help; and has been granted a power of producing harmony from partial confusion.

If, therefore, we consider the earth as allotted for our habitation, we shall find, that much has been given us to enjoy, and much to amend; that we have ample reasons for our gratitude, and still more for our industry. In those great outlines of nature,



to which art cannot reach, and where our greatest efforts must have been ineffectual, God himself has finished these with amazing grandeur and beauty. Our beneficent Father has considered these parts of nature as peculiarly his own; as parts which no creature could have skill or strength to amend; and therefore, made them incapable of alteration, or of more perfect regularity. The heavens, and the firmament, shew the wisdom, and the glory of the Workman. Astronomers, who are best skilled in the symmetry of systems, can find nothing there that they can alter for the better. God made these perfect, because no subordinate being could correct their defects.

When, therefore, we survey nature on this side, nothing can be more splendid, more correct, or amazing. We there behold a Deity residing in the midst of an universe, infinitely extended every way, animating all, and cheering the vacuity with his presence! We behold an immense and shapeless mass of matter, formed into worlds by his power, and dispersed at intervals, to which even the imagination cannot travel! In this great theatre of his glory, a thousand suns, like our own, animate their respective systems, appearing and vanishing at divine command. We behold our own bright luminary, fixed in the center of its system, wheeling its planets in times proportioned to their distances, and at once dispensing light, heat, and action. The earth also is seen with its twofold motion; producing, by the one, the change of seasons; and, by the other, the grateful vicissitudes of day and night. With what silent magnificence is all this performed! with what seeming ease! The works of art are exerted with interrupted force; and their noisy progress discovers the obstructions they receive: but the earth, with a silent steady rotation, successively presents every part of its bosom to the sun; at once imbibing nourishment and light from that parent of vegetation and fertility.

But not only provisions of heat and light are thus supplied, but its whole surface is covered with a transparent atmosphere, that turns with its motion, and guards it from external injury. The rays of the sun are thus broken into a genial warmth; and, while the surface is assisted, a gentle heat is produced in the bowels of the earth, which contributes to cover it with verdure. Waters also are supplied in healthful abundance, to support life,

and assist vegetation. Mountains arise, to diversify the prospect, and give a current to the stream. Seas extend from one continent to the other, replenished with animals, that may be turned to human support; and also serving to enrich the earth with a sufficiency of vapour. Breezes fly along the surface of the fields, to promote health and vegetation. The coolness of the evening invites to rest; and the freshness of the morning renews for labour.

Such are the delights of the habitation that has been assigned to man; without any one of these he must have been wretched; and none of these could his own industry have supplied. But while many of his wants are thus kindly furnished, on the one hand, there are numberless inconveniencies to excite his industry on the other. This habitation, though provided with all the conveniencies of air, pasture, age, and water, is but a desert place, without human cultivation. The lowest animal finds more conveniencies in the wilds of nature, than he who boasts himself their lord. The whirlwind, the inundation, and all the asperities of the air, are peculiarly terrible to man, who knows their consequences, and, at a distance, dreads their approach. The earth itself, where human art has not pervaded, puts on a frightful gloomy appearance. The forests are dark and tangled; the meadows overgrown with rank weeds; and the brooks stray without a determined channel. Nature, that has been kind to every lower order of beings, has been quite neglectful with regard to him; to the savage uncontriving man the earth is an abode of desolation, where his shelter is insufficient, and his food precarious.

A world thus furnished with advantages on one side, and inconveniencies on the other, is the proper abode of reason, is the fittest to exercise the industry of a free and a thinking creature. These evils, which art can remedy, and prescience guard against, are a proper call for the exertion of his faculties; and they tend still more to assimilate him to his Creator. God beholds with pleasure, that being which he has made, converting the wretchedness of his natural situation into a theatre of triumph; bringing all the headlong tribes of nature into subjection to his will; and producing that order and uniformity upon earth, of which his own heavenly fabric is so bright an example.





**NEW, COMPLETE, and UNIVERSAL BODY, or SYSTEM of  
NATURAL HISTORY;**

**Being a Grand, Accurate and Extensive  
Display of Animated Nature.**

**B O O K VII.**

*Containing the* **NATURAL HISTORY of MAN.**

**C H A P. I.**

**Of the Nature of M A N.**

**H**AVING given an account of the Earth in general, and the advantages and inconveniences with which it abounds, we shall now proceed to give the Natural History of Man. Though it is so much our interest to acquire an exact and thorough knowledge of ourselves, yet we are often less acquainted with the human, than with any other existence. Provided by nature with organs, calculated solely for our preservation, we never employ those organs but to receive foreign impressions; our only study is, to acquire a familiarity with external objects, and to exist out of ourselves. Too intent on multiplying the functions of our senses, and on enlarging the external bounds of our being, rarely do we make any use of that internal sense which reduces us to our true dimensions, and which abstracts from us whatever does not constitute a part of ourselves. It is by an exertion of this sense alone, however, that we can form a proper judgment of ourselves. But how shall it receive its full activity and extent? How shall the soul, in which it resides, be disengaged from all the illusions of the mind? Having lost the habit of employing it, it has remained inactive amidst the tumult of our corporeal sensations; it has been, as it were, dried up by the fire of our passions; the heart, the mind, the senses, have all co-operated against it.

Unalterable in its substance, and impassible by its essence, it still, however, continues the same. The splendor of its light has been overcast, but its power has not been diminished. It is less luminous; but its guidance is not the less certain. Let us then collect those rays, of which we are not yet deprived. The obscurity with which we are surrounded will decrease; and though the road may not be every where equally filled with light, we yet

shall have a torch that will prevent us from going astray.

The first, and indeed the most difficult step, which leads to the knowledge of ourselves, is, a distinct conception of the nature of the two substances that constitute our being. To say simply, that the one is unextended, immaterial and immortal; and that the other is extended, material and mortal, is only to deny of one thing, what we affirm of another. What knowledge is to be acquired from this mode of negation? Such private expressions can exhibit no real and positive idea; but to say, that we are certain of the existence of the former, and that the existence of the latter is less evident; that the substance of the one is simple, indivisible, and of one form, since it only manifests itself by a single modification, which is thought; that the other is less a substance than a subject, capable of receiving different forms, which bear a relation to those of our senses, but all as uncertain, all as variable, as the nature of the organs themselves: That is to say something; it is to ascribe to each such distinct and positive properties, as may lead us to an elemental knowledge of both, and to a comparison between them.

From the smallest reflection on the origin of our knowledge, it is easy, indeed, to perceive, that by comparison alone, we can acquire it. What is absolutely incomparable, is utterly incomprehensible; of this, God is the only instance we can adduce; he exceeds all comprehension, because he is above all comparison. But whatever is capable of being compared, whatever we can contemplate in different lights, whatever we can consider relatively, may always conclude to come within the sphere of our understanding. The more subjects of comparison, the more different views, or particular appearances, we have for examining any object, the more methods there are for obtaining a knowledge of it, and the greater facility there is to combine those ideas which ought to direct our judgment.



The existence of the soul is demonstrated to us; or rather that existence and ourselves form but one and the same thing. To be and to think, are with us identical. This truth is within us, and it is more than intuitive; it is independent of our senses, of our imagination, of our memory, and of all our other relative faculties. The existence of our body, and of other external objects, is held in uncertainty by every unprejudiced reasoner; for what is that extension of length, breadth and depth, which we call our body, and which seems to be so much our own, but as it relates to our senses? What are even the material organs of those senses, but so many conformities with what affects them? And, with regard to our internal sense, our soul, has it any thing similar, any thing in common, with the nature of these external organs? Does the sensation excited in our soul by light or sound, resemble that tenuous matter, which seems to diffuse light, or even that tremulous undulation, which sound produces in the air? Our eyes and our ears have every necessary conformity with these matters, because those organs and matter itself, are, in effect, of the same nature. The sensation, however, which the soul experiences, has nothing similar, nothing analogous to it; and is not this a sufficient proof, that the nature of the soul is in reality different from that of matter?

It is a certain truth, then, that the internal sensation is altogether different from its cause; as also, that, if there are things which exist without us, they are in themselves totally different from what we conceive them to be. As the sensation therefore, bears no kind of resemblance to the thing which is the cause of it; does it not follow, that what excites our sensations is necessarily, and of its own nature, quite another thing than we imagine it? The extension which we perceive by our eyes, the impenetrability, of which we receive an idea by the touch, all those qualities, whose various combinations constitute matter, are of a doubtful existence; since our inward sensation, and what it represents to us as extension, impenetrability, &c. are no wise extended or impenetrable, and have not even the smallest affinity with those qualities.

If it is observed, that the soul is often affected with sensations, during sleep, and the absence of every object; and that these sensations are sometimes very different from those, which it has experienced by the presence of the same objects, through the channel of the senses; does it not lead to a belief, that this presence of objects is not necessary to the existence of our sensations; and that, of consequence, our soul and we may exist singly, and independently of those objects? During sleep, and after death, for example, our body exists; it has even all that kind of existence of which it is susceptible, and is the same as it was before; yet the soul no longer perceives this existence of the body; it has ceased to be with regard to us. The question is therefore, whether a thing which can exist, and afterwards not exist; whether a thing, which affects us in a manner altogether different from what it is, or what it has been, may yet be a reality of indubitable existence.

That something exists without us, we may believe, though not with a positive assurance; whereas of the real existence of every thing within us, we have a certainty. That of our soul therefore, is incontestible, and that of our body seems doubtful; because matter may be only a mode of the soul, one of its methods of perception. Our soul perceives by this method, when we are awake; it perceives by another method, when we are asleep; after death, it will perceive by a method far more different still: and whatever is, in the present state, the cause of its sensations, matter in general may well cease to exist,

with respect to it, when all communication with its own body is cut off.

But let us admit this existence of matter; let us, though it is impossible to demonstrate it, adopt the common opinion, and say, that it even exists as it appears to our senses, by comparing the soul with any material object, we shall then find differences so great, and contrarieties so strongly marked, that every doubt will instantly vanish of its being of a nature totally different, and of an order infinitely superior.

Our soul has but one form, which is very simple, very general, and very permanent. Thought is this form; otherwise than by thought, it is impossible for us to perceive the soul. This form has nothing in it of division and extension, nothing of impenetrability, or matter; of consequence, therefore, our soul, the subject of this form, is indivisible, and immaterial. Our body on the contrary, and all other bodies, have many forms. Every one of these is compounded, divisible, variable, perishable, and has a relation to the different organs, through which we perceive them. Our body, therefore, any things material, having nothing permanent, nothing real, nothing general, by which we may fix our researches, and attain a certain knowledge of them. A blind man has no idea of that part of a material object, which represents to us the form of bodies; a leper, whose skin has lost the sense of feeling, is denied all the ideas which arise from the touch; and a deaf man has no knowledge of sounds. Let these three modes of sensation be successively destroyed, in a man whom nature has provided with them, and the soul will exist in its wonted vigour; its internal functions will subsist, and thought will still manifest itself within him. On the other hand, divest matter of all its qualities; strip it of colour, of strength, of solidity, and of every other property which has any relation to our senses, and the consequence will be its annihilation. Our soul therefore, is unperishable, but matter may, and will perish.

Thus it is with all the other faculties of our soul, compared with those of our body, and with the most essential properties of any kind of matter. As the soul wills and commands, so the body obeys in every thing within its power. The soul forms, at pleasure, an intimate union with any object: neither distance, nor magnitude, nor figure, can obstruct this union, when the soul inclines to it; it is effected, and effected in an instant. The body can form no union: whatever touches it too closely injures it; it requires a long time in order to approach another body; it every where meets with some resistance, with some obstacle; from the smallest shock, its motion ceases. Is will then nothing more than a corporeal movement; and is contemplation but a simple contact? How could this contact take place upon a remote object, upon an abstracted subject? How could this movement be accomplished in an indivisible instant? Is it possible to have a conception of motion, without having a conception of space, and of time? Will, therefore, if it be a motion, is not a material one; and if the union of the soul to a particular object be a touch, a contact, is not this touch effected at a distance; is not this contact a penetration; qualities which are absolutely opposite to those of matter, and which of consequence cannot belong to an immaterial being?

But we have already dwelt too long on a subject, which by many will perhaps be considered as foreign to our purpose. Ought Considerations on the Soul to find a place in a system of Natural History? Why, after all, retrench from the Natural History of Man, the history of the noblest part of his being? Why thus preposterously debate him, and, as it were, force us to consider him merely as an animal; while



in reality, he is of a nature so different and distinguished, so superior to that of the brutes, that he who confounds them must be immersed in ignorance as themselves?

In comparing man with an animal, we find in both a body, an organised substance, senses, flesh, blood, motion, and a multitude of other resemblances. But these resemblances, are all external, and not sufficient to justify a decision, that the human and the animal natures are similar. In order to form a proper judgment of the nature of each, we ought to have as distinct a knowledge of the internal qualities of an animal, as we have of our own. As the knowledge, however, of what passes within an animal is impossible to be attained; as we know not of what order and kind its sensations may be, in relation to those of man; we may judge solely from a comparison of the effects of the natural operations of both.

Let us, then, take a view of these effects; and, while we admit of all the particular resemblances, limit our investigation to the most general differences. It will be allowed, that the most stupid man is able to manage the most acute animal: he governs it, and renders it subservient to his purposes; and this, not so much on account of his strength or skill, as of the superiority of his nature, and of his having a rational scheme, system of action, and method by which he compels the animals to obey him. We do not find, that the strongest and most expert animals give law to the others, and hold them in servitude. The stronger, it is true, devour the weaker; but this action implies no more than an urgent necessity, or a rage of appetite; a quality very different from that which is capable of producing a series of actions, all tending to the same end. Did animals enjoy this faculty, should we not see some of them assume dominion over others, and oblige them to furnish them with food, to watch over them and to attend them when sick or wounded? Now, throughout the creation of animals, there is no vestige of such subordination; no appearance that one of them knows, or is sensible of, the superiority of his own nature over that of others. It follows, then, that they must all be considered as of one nature; as also, that the nature of man is not only highly superior to that of any animal, but also entirely different from it.

Man, by an outward sign, indicates what passes within him; he communicates his sentiments by speech, which is a sign common to the whole human species. The savage and the civilized man have the same power of utterance; they both speak naturally, and speak so as to be understood. No animal is endowed with this expression of thought; nor is it a defect owing, as is commonly imagined, to the want of proper organs. Anatomists have found the tongue of an ape to be as perfect as that of a man. The ape, therefore, if he had thought, it would have speech; and if its thought had aught analogous to ours, this speech would have an analogy to ours also. Supposing its thoughts were only the thoughts of an ape, it still would hold some kind of discourse with other apes; a circumstance, of which we should certainly have heard, had it been endowed with the powers of speech. So far, then, is the ape from having any thought like ours, that it has not even any order or series of thoughts of its own. Nothing regular, nothing connected, passes within it; for as it expresses nothing by combined and settled signs, so it is, of consequence, void of thought, even in the lowest degree.

So true it is, that it is from no organical defect, animals are denied the gift of speech, that we know several species of them which may be taught to pronounce words, and even repeat sentences of some length. Perhaps, were we to take the trouble to

teach them, many others might be found capable of articulating particular sounds; but to make them conceive the idea which such sounds denote, is an impracticable task. They seem to repeat and even to articulate them, merely as an echo, or an artificial machine, would repeat or articulate. It is not in the mechanical powers, or the material organs, but in the intellectual faculty, in thought, that they are deficient.

As all language supposes a chain of thought, it is on this account that animals have none; for, even allowing something in them which resembles our first apprehensions, our most gross and mechanical sensations, they still will be found incapable of forming that association of ideas, which can alone produce reflection; and in this, be it remarked, consists the essence of thought. To this inability of connecting ideas, it is owing, that they are destitute of thought and speech; as also, that they neither can invent nor improve any thing. Were they endowed with the power of reflection, even in the most subordinate degree, they would be capable of making some kind of proficiency, and would acquire more industry: the modern beaver would build with more art and solidity than the ancient; and the bee would daily be adding new improvements to its cell. If we suppose this cell as perfect already as it can be, we ascribe to the insect an intelligence superior to our own; an intelligence whereby it could discern at once the last degree of perfection to which its work might be carried; while we ourselves are for ever in the dark as to this degree, and stand in need of much reflection, time and practice, in order to perfect even one of our most trivial arts.

Whence can arise that uniformity we observe in all the works of animals? Why does each species invariably perform the same actions in the same manner? And why does not one individual perform them better or worse than another? Can there be a stronger proof that their operations are merely the effects of mechanism and materiality; evidently as it follows, that if they possessed the smallest spark of that light which is inherent in us, their works would display variety at least, if they did not display perfection; and that one individual of the same species would, in some of its performances, do something a little different from what another had done? But this is far from being the case. One plan of action is common to the whole species, and whoever would attribute a soul to animals, must of necessity, allow but one to each species. Of this soul each individual would be an equal partaker; and as thereby it would be divisible, it would consequently be material, and of a nature widely different from ours.

Why, on the other hand, are our productions and performances so various and so diversified? Why is a servile imitation more troublesome to us than an original design? It is because our soul is our own; because it is independent on that of another; because we have nothing in common with our species, but the substance of our body; and because, in effect, our resemblance to animals is confined to the lowest of our faculties.

Were internal sensations annexed to matter, and dependent on the corporeal organs, should we not see as remarkable differences in the works of animals of the same species, as in those of men? Would not those which were the most happily organized, build their nests, contrive their cells, or lay their eggs, in a manner more solid, more elegant and more commodious? And would not some individual, possessed of a superior genius, take an opportunity to manifest that superiority in this very mode? Now nothing of this very kind has ever happened; and therefore the corporeal organs, however perfect or imperfect, have no influence on the nature of



the internal sensations. Hence may we conclude, that animals have no sensations of this kind; that such sensations have no connection with matter; no dependence, in their nature, on the corporeal organs; and that, of consequence, there must be a substance within us, different from matter, which is at once the subject and the cause that produces and receives those sensations.

But these proofs of the immateriality of the soul may be carried farther still. In all the works of nature, there are imperceptible gradations maintained. This truth, which in no other instance admits of exception, is here expressly contradicted; between the faculties of man, and those of the most perfect animal, the distance is infinite; an evident proof, that man is of a different nature, and that of himself he forms a distinct class, between which and that of animals, there is an immense chasm. If man belonged to the class of animals, there would be a certain number of beings in nature less perfect than the former, and more perfect than the latter, in order to compleat the gradation of man to the monkey. But this is not the case; the transition is immediate from the thinking being to the material being; from intellectual power to mechanical force; from order and design to blind motion; from reflection to appetite.

To the ingenuous enquirer after truth more than enough has been here advanced, as demonstrative of the excellency of our nature, and of the immense distance which the Creator has placed between man and the brute. The former is a rational being, the latter a being devoid of reason. And as there is no medium between the positive and the negative; as there are no intermediate beings between the rational being, and the being devoid of reason; it is evident, that man is of a nature entirely different from that of the animal; that all the resemblance he bears to it is merely external; and that to judge of him by this resemblance, is to allow ourselves to be deceived by appearance, and wilfully to shut our eyes against that light, by which we ought to distinguish it from reality.

Having thus considered man as to his internal properties, we shall now proceed to examine his external ones, and to give the history of his body. After taking a view of the different stages of his life, we shall conduct him to the period when he must be separated from that body, and then resign him to the common mass of matter to which he belongs.

## CHAP. II.

### The Infancy of MAN.

**I**N surveying the various classes of animals, and examining their strength, their beauty, or their structure, we find man possesses most of those advantages united, which the rest enjoy partially. Infinitely superior to all others in the powers of the understanding, he is also superior to them in the fitness and proportions of his form. He would, indeed, have been one of the most miserable beings upon earth, if with a sentient mind he was so formed as to be incapable of obeying its impulse; but Nature has otherwise provided; as with the most extensive intellects to command, she has furnished him with a body the best fitted for obedience.

In infancy, however, that mind, and this body, form the most helpless union in all animated nature; and, if any thing can give us a picture of complete imbecillity, it is a man when just come into the world. The infant just born stands in need of all things, without the power of procuring any.

The lower races of animals, upon being produced, are active, vigorous, and capable of self-support; but the infant is obliged to wait in helpless expectation; and its cries are its only aid to procure subsistence.

An infant just born may be said to come from one element into another; for from the watery fluid in which it was surrounded, it now immerses into air; and its first cries seem to imply how greatly it regrets the change. How much longer it could have continued in a state of almost total insensibility, in the womb, is impossible to tell; but it is very probable that it could remain there some hours more. In order to throw some light upon this subject, Mr. Buffon so placed a pregnant bitch as that her puppies were brought forth in warm water, in which he kept them above half an hour at a time. However, he saw no change in the animals, thus newly brought forth; they continued the whole time vigorous; and, during the whole time, it is very probable that the blood circulated through the same channels through which it passed while they continued in the womb.

Almost all animals have their eyes closed, for some days after being brought into the world. The infant opens them the instant of its birth. However, it seems to keep them fixed and idle; they want that lustre which they acquire by degrees; and if they happen to move, it is rather an accidental gaze than an exertion of the act of seeing. The light alone seems to make the greatest impression upon them. The eyes of infants are sometimes found turned to the place where it is strongest; and the pupil is seen to dilate and diminish, as in grown persons, in proportion to the quantity it receives. But still, the infant is incapable of distinguishing objects; the sense of seeing, like the rest of the senses, requires an habit before it becomes any way serviceable. All the senses must be compared with each other, and must be made to correct the defects of one another, before they can give just information. It is probable, therefore, that if the infant could express its own sensations, it would give a very extraordinary description of the illusions which it suffers from them. The sight might, perhaps, be represented as inverting objects, or multiplying them; the hearing, instead of conveying one uniform tone, might be said to bring up an interrupted succession of noises; and the touch apparently would divide one body into as many as there are fingers that grasped it. But all these errors are lost in one common confused idea of existence; and it is happy for the infant, that it then can make but very little use of its senses, when they could serve only to bring it false information.

If there be any distinct sensations, those of pain seem to be much more frequent and stronger than those of pleasure. The infant's cries are sufficient indications of the uneasinesses it must at every interval endure; while, in the beginning, it has got no external marks to testify its satisfactions. It is not till after forty days that it is seen to smile; and not till that time also, the tears begin to appear, its former expressions of uneasiness being always without them. As to any other marks of the passions, the infant being as yet almost without them, it can express none of them in its visage; which, except in the act of crying and laughing, is fixed in a settled serenity. All the other parts of the body seem equally relaxed and feeble: its motions are uncertain, and its postures without choice; it is unable to stand upright; its limbs are yet bent, from the habit which it received from its position in the womb; it has not strength enough in its arms to stretch them forward, much less to grasp any thing with its hands; it rests just in the posture it is laid; and, if abandoned, must continue in the same position.

Never-



Nevertheless, though this be the description of infancy among mankind in general, there are countries, and races, among whom infancy does not seem marked with such utter imbecillity; but where the children, not long after they are born, appear possessed of a greater share of self-support. The children of Negroes have a surprising degree of this premature industry: they are able to walk at two months; or, at least, to move from one place to another: they also hang to the mother's back without any assistance, and seize the breast over her shoulder, continuing in this posture till she thinks proper to lay them down. This is very different in the children of our countries, that seldom are able to walk under a twelvemonth.

The skin of children newly brought forth, is always red, proceeding from its transparency, by which the blood beneath appears more conspicuous. Some say that this redness is greatest in those children that are afterwards about to have the finest complexions; and it appears reasonable that it should be so, since the thinnest skins are always the fairest. The size of a new-born infant is generally about twenty inches, and its weight about twelve pounds. The head is large, and all the members delicate, soft, and puffy. These appearances alter with its age; as it grows older, the head becomes less in proportion to the rest of the body; the flesh hardens: the bones that before birth grew very thick in proportion, now lengthen by degrees, and the human figure more and more acquires its due dimensions. In such children, however, as are but feeble or sickly, the head always continues too big for the body; the heads of dwarfs being extremely large in proportion.

Infants, when newly born, pass most of their time in sleeping, and awake with crying, excited either by sensations of pain, or of hunger. Man, when come to maturity, but rarely feels the want of food, as eating twice or thrice in the four and twenty hours is known to suffice the most voracious: but the infant may be considered as a little glutton, whose only pleasure consists in its appetite; and this, except when it sleeps, it is never easy without satisfying. Thus Nature has adapted different desires to the different periods of life; each as it seems most necessary for human support or succession. While the animal is yet forming, hunger excites it to that supply which is necessary for its growth; when it is completely formed, a different appetite takes place, that incites it to communicate existence. These two desires take up the whole attention at different periods, but are very seldom found to prevail strongly together in the same age; one pleasure ever serving to repress the other: and, if we find a person of full age, placing a principal part of his happiness in the nature and quantity of his food, we have strong reasons to suspect, that with respect to his other appetites, he still retains a part of the imbecillity of his childhood.

It is extraordinary, however, that infants, who are thus more voracious than grown persons, are nevertheless more capable of sustaining hunger. We have several instances, in accidental cases of famine, in which the child has been known to survive the parent; and seen clinging to the breast of their dead mother. Their little bodies also, are more patient of cold; and we have similar instances of the mother's perishing in the snow, while the infant has been found alive beside her. However, if we examine the internal structure of infants, we shall find an obvious reason for both these advantages. Their blood-vessels are known to be much larger than in adults; and their nerves much thicker and softer: thus, being furnished with a more copious quantity of juices, both of the nervous and sanguinary kinds, the infant finds a temporary sustenance

in this superfluity, and does not expire till both are exhausted. The circulation also being larger and quicker, supplies it with proportionable warmth, so that it is more capable of resisting the accidental rigours of the weather.

The first nourishment of infants is well known to be the mother's milk; and, what is remarkable, the infant has milk in its own breasts, which may be squeezed out by compression: this nourishment becomes less grateful as the child gathers strength; and perhaps, also, more unwholesome. However, in cold countries, which are unfavourable to propagation, and where the female has seldom above three or four children at the most, during her life, she continues to suckle the child for four or five years together. In this manner the mothers of Canada and Greenland are often seen suckling two or three children, of different ages, at a time.

The life of infants is very precarious, till the age of three or four, from which time it becomes more secure; and when a child arrives at its seventh year, it is then considered as a more certain life, as Mr. Buffon asserts, than at any other age whatever. It appears, from Simpson's Tables, that of a certain number of children born at the same time, a fourth part are found dead, at the end of the first year; more than two thirds at the end of the second; and, at least, half, at the end of the third: so that those who live to be above three years old, are indulged a longer term than half the rest of their fellow-creatures. Nevertheless, life, at that period, may be considered as mere animal existence; and rather a preparation for, than an enjoyment of those satisfactions, both of mind and body, that make life of real value: and hence it is more natural for mankind to deplore a fellow-creature, cut off in the bloom of life, than one dying in early infancy. The one, by living up to youth, and thus wading through the disadvantageous parts of existence, seems to have earned a short continuance of its enjoyments; the infant, on the contrary, has served but a short apprenticeship to pain; and, when taken away, may be considered as rescued from a long continuance of misery.

There is something very remarkable in the growth of the human body. The embryo in the womb continues to increase still more and more, till it is born. On the other hand, the child's growth is less every year till the time of puberty, when it seems to start up of a sudden. Thus, for instance, the embryo, which is an inch long, in the first month, grows but one inch and a quarter in the second; it then grows one and a half in the third; two and a half in the fourth; and in this manner it keeps increasing, till in the last month of its continuance, it is actually found to grow four inches; and, in the whole, about eighteen inches long. But it is otherwise with the child when born: if we suppose it eighteen inches at that time, it grows, in the first year, six or seven inches; in the second year, it grows but four inches; in the third year about three; and so on, at the rate of about an inch and a half or two inches, each year, till the time of puberty, when Nature seems to make one great last effort, to complete her work, and unfold the whole animal machine.

The growth of the mind in children seems to correspond with that of the body. The comparative progress of the understanding is greater in infants than in children of three or four years old. If we only reflect a moment on the amazing acquisitions that an infant makes in the first and second years of life, we shall have much cause for wonder. Being sent into a world where every thing is new and unknown, the first months of life are spent in a kind of torpid amazement; an attention distracted by the multiplicity of objects that press to be



be known. The first labour, therefore, of the little learner is, to correct the illusions of the senses, to distinguish one object from another, and to exert the memory, so as to know them again. In this manner a child of a year old has already made a thousand experiments; all which it has properly ranged, and distinctly remembers. Light, heat, fire, sweets, and bitters, sounds soft or terrible, are all distinguished at the end of a very few months. Besides this, every person the child knows, every individual object it becomes fond of, its rattles, or its bells, may be all considered as so many new lessons to the young mind, with which it has not become acquainted, without repeated exertions of the understanding. At this period of life, the knowledge of every individual object cannot be acquired without the same effort which, when grown up, is employed upon the most abstract idea: every thing the child hears or sees, all the marks and characters of nature, are as much unknown, and require the same attention to attain, as if the reader were set to understand the characters of an Ethiopic manuscript; and yet we see in how short a time, the little student begins to understand them all, and to give evident marks of early industry.

It is very amusing to pursue the young mind, while employed in its first attainments. At about a year old, the same necessities that first engaged its faculties, increase, as its acquaintance with nature enlarges. Its studies, therefore, if we may so express it, are no way relaxed; for having experienced what gave pleasure at one time, it desires a repetition of it from the same object; and, in order to obtain this, that object must be pointed out: here, therefore, a new necessity arises, which, very often, neither its little arts nor importunities can remove; so that the child is at last obliged to set about naming the objects it desires to possess or avoid. In beginning to speak, which is usually about a year old, children find a thousand difficulties. It is not without repeated trials that they come to pronounce any one of the letters; nor without an effort of the memory, that they can retain them. For this reason, we frequently see them attempting a sound which they had learned, but forgot; and when they have failed, their attempt is often attended with apparent confusion. The letters soonest learned, are those which are most easily formed; thus A and B require an obvious disposition of the organs, and their pronunciation is consequently soon attained. Z and R, which require a more complicated position, are learned with greater difficulty. And this may, perhaps, be the reason why the children in some countries speak sooner than in others; for the letters, mostly occurring in the language of one country, being such as are of easy pronunciation, that language is of course more easily attained. In this manner the children of the Italians are said to speak sooner than those of the Germans; the language of the one being smooth and open; that of the other, crowded with consonants, and extremely guttural.

But be this as it will, in all countries, children are found able to express the greatest part of their wants by the time they arrive at two years old; and from the moment the necessity of learning new words ceases, they relax their industry. It is then that the mind, like the body, seems every year to make slow advances; and, in order to spur up attention, many systems of education have been contrived.

Almost every philosopher who has written on the education of children, has been willing to point out a method of his own, chiefly professing to advance the health, and improve the intellects at the same time. These are usually found to begin with finding nothing right in the common practice; and

by urging a total reformation. In consequence of this, nothing can be more wild or imaginary than their various systems of improvement. Some will have the children every day plunged in cold water, in order to strengthen their bodies; they will have them converse with the servants in nothing but the Latin language, in order to strengthen their minds; every hour of the day must be appointed for its own studies, and the child must learn to make these very studies an amusement; till about the age of ten or eleven it becomes a prodigy of premature improvement. Quite opposite to this, we have others, whom the courtesy of mankind also calls philosophers: and they will have the child learn nothing till the age of ten or eleven, at which the former has attained so much perfection; with them the mind is to be kept empty, until it has a proper distinction of some metaphysical ideas about truth; and the promising pupil is debarred the use of even his own faculties, lest they should conduct him into prejudice and error. In this manner, some men, whom fashion has celebrated for profound and fine thinkers, have given their hazarded and untried conjectures, upon one of the most important subjects in the world, and the most interesting to humanity. When men speculate at liberty upon innate ideas, or the abstracted distinctions between will and power, they may be permitted to enjoy their systems at pleasure, as they are harmless, although they may be wrong; but when they alledge that children are to be every day plunged in cold water, and, whatever be their constitution, indiscriminately inured to cold and moisture; that they are to be kept wet in the feet, to prevent their catching cold; and never to be corrected when young, for fear of breaking their spirits when old; these are such noxious errors, that all reasonable men should endeavour to oppose them. Many have been the children whom these opinions began in speculation, have injured or destroyed in practice.

If any system be therefore necessary, it is one that would serve to shew, a very plain point; that very little system is necessary. The natural and common course of education is in every respect the best: We mean that in which the child is permitted to play among its little equals, from whose similar instructions it often gains the most useful stores of knowledge. A child is not idle because it is playing about the fields, or pursuing a butterfly; it is all this time storing its mind with objects, upon the nature, the properties, and the relations of which future curiosity may speculate.

It is a vain task to try to make a child's learning its amusement; nor would it answer any good end were it actually attained. The child, as was said, ought to have its share of play, and it will be benefited thereby; and for every reason also, it ought to have its share of labour. The mind, by early labour, will be thus accustomed to fatigues and subordination; and whatever be the person's future employment in life, he will be better fitted to endure it: he will be thus enabled to support the drudgeries of office, with content; or to fill up the vacancies of life with variety. The child, therefore, should by times be put to its duty; and be taught to know, that the task is to be done, or the punishment to be endured. We do not object against alluring it to duty by reward; but we well know, that the mind will be more strongly stimulated by pain; and both may, upon some occasions, take their turn to operate. In this manner, a child, by playing with its equals abroad, and labouring with them at school, will acquire more health and knowledge than by being bred up under the wing of any speculative system-maker; and will be thus qualified for a life of activity and obedience. It is true, indeed, that when educated in this manner, the boy may not be



so seemingly sensible and forward as one bred up under solitary instruction; and, perhaps, this early forwardness is more engaging than useful. It is well known, that many of those children who have been such prodigies of literature before ten, have not made an adequate progress to twenty. It should seem, that they only began learning manly things before their time; and, while others were busied in picking up that knowledge adapted to their age and curiosity, these were forced upon subjects unsuited to their years; and, upon that account alone, appearing extraordinary. The stock of knowledge in both may be equal; but with this difference, that each is yet to learn what the other knows.

But whatever may have been the acquisitions of children at ten or twelve, their greatest, and most rapid progress, is made when they arrive near the age of puberty. It is then that all the powers of nature seem at work in strengthening the mind, and completing the body; the youth acquires courage, and the virgin modesty; the mind, with new sensations, assumes new powers; it conceives with greater force, and remembers with greater tenacity. About this time, therefore, which is various in different countries, more is learned in one year than in any two of the preceding: and on this age, in particular, the greatest weight of instruction ought to be thrown.

#### CHAP. IV. OF PUBERTY.

IT is a common saying, that the season of youth is the season of pleasures: but this can only be true in savage countries, where but little preparation is made for the perfection of human nature; and where the mind has but a very small part in the enjoyment. It is otherwise in those places where nature is carried to the highest pitch of refinement, in which this season of the greatest sensual delight is wisely made subservient to the succeeding, and more rational one of manhood. Youth, with us, is but a scene of preparation; a drama, upon the right conduct of which all future happiness is to depend. The youth who follows his appetites, too soon seizes the cup, before it has received its best ingredients; and, by anticipating his pleasures, robs the remaining parts of life of their share; so that his eagerness only produces a manhood of imbecility, and an age of pain.

The time of puberty is different in various countries, and always more late in men than in women. In the warm countries, of India, the women are marriageable at nine or ten, and the men at twelve or thirteen. It is also different in cities where the inhabitants lead a more soft, luxurious life, from the country where they work harder, and fare less delicately. Its symptoms are seldom alike in different persons; but it is usually known by a swelling of the breasts in one sex, and a roughness of the voice in the other. At this season also, the women seem to acquire new beauty, while the men lose all that delicate effeminacy of countenance which they had when boys.

All countries, in proportion as they are civilized, or barbarous, improve, or degrade the nuptial satisfaction. In those miserable regions, where strength makes the only law, the stronger sex exerts its power, and becomes the tyrant over the weaker: while the inhabitant of Negroland is indolently taking his pleasure in the fields, his wife is obliged to till the grounds, that serve for their mutual support. It is thus in all barbarous countries, where the men throw all the laborious duties of life upon the

women; and, regardless of beauty, put the softer sex to those employments that must effectually destroy it.

But, in countries that are half barbarous, particularly wherever Mahometanism prevails, the men run into the very opposite extreme. Equally brutal with the former, they exert their tyranny over the weaker sex, and consider that half of the human creation as merely made to be subservient to the depraved desires of the other. The chief, and indeed the only aim of an Asiatic, is to be possessor of many women; and to be able to furnish a seraglio is the only tendency of his ambition. As the savage was totally regardless of beauty, he on the contrary, prizes it too highly; he excludes the person who is possessor of such personal attractions, from any share in the duties, or employments of life; and, as if willing to engross all beauty to himself, increases the number of his captives in proportion to the progress of his fortune. In this manner he vainly expects to augment his satisfactions, by seeking from many that happiness which he ought to look for in the society of one alone. He lives a gloomy tyrant, amidst wretches of his own making; he feels none of those endearments which spring from affection, none of those delicacies which arise from knowledge. His mistresses, being shut out from the world, and totally ignorant of all that passes there, have no arts to entertain his mind, or calm his anxieties; the day passes with them in sullen silence, or languid repose; appetite can furnish but few opportunities of varying the scene; and all that falls beyond it must be irksome expectation.

From this avarice of women, if we may so express it, has proceeded that jealousy and suspicion which ever attends the miser: hence those low and barbarous methods of keeping the women of those countries guarded, and of making, and procuring eunuchs to attend them. These unhappy creatures are of two kinds, the white and the black. The white are generally made in the country where they reside, being but partly deprived of the marks of virility; the black are generally brought from the interior parts of Africa, and are made entirely bare. These are chiefly chosen for their deformity: the thicker the lips, the flatter the nose, and the more black the teeth, the more valuable the eunuch; so that the vile jealousy of mankind here inverts the order of Nature; and the poor wretch finds himself valued in proportion to his deficiencies. In Italy, where this barbarous custom is still retained, and eunuchs are made, in order to improve the voice, the laws are severely aimed against such practice; so that being entirely prohibited, none but the poorest, and most abandoned of the people, still secretly practice it upon their children. Of those served in this manner, not one in ten is found to become a singer; but such is the luxurious folly of the times, that the success of one amply compensates for the failure of the rest. It is very difficult to account for the alterations which castration make in the voice, and the other parts of the body. The eunuch is shaped differently from others. His legs are of an equal thickness above and below; his knees weak; his shoulders narrow; and his beard thin and downy. In this manner his person is rendered more deformed; but his desires, as we are told, still continue the same; and actually, in Asia, some of them are found to have their seragios, as well as their masters. Even in our country, we have an instance of a very fine woman's being married to one of them, whose appearance was the most unpromising; and, what is more extraordinary still, this couple continue perfectly happy in each other's society.

The mere necessities of life seem the only aim of the



the savage; the sensual pleasures are the only study of the semi-barbarian; but the refinement of sensuality, by reason, is the boast of real politeness. Among the merely barbarous nations, such as the natives of Madagascar, or the inhabitants of Congo, nothing is desired so ardently as to prostitute their wives, or daughters, to strangers, for the most trifling advantages; they will account it a dishonour not to be among the foremost who are thus received into favour; on the other hand, the Mahometan keeps his wife faithful, by confining her person; and would instantly put her to death if he but suspected her chastity. With the politer inhabitants of Europe both these barbarous extremes are avoided; the woman's person is left free, and no constraint is imposed but upon her affections. The passion of love, which may be considered as the nice conduct of ruder desire, is only known, and practised in this part of the world; so that what other nations guard as their right, the more delicate European is contented to ask as a favour. In this manner, the concurrence of mutual appetite contributes to increase mutual satisfaction; and the power on one side of refusing, makes every blessing more grateful when obtained by the other. In barbarous countries, woman is considered merely as an useful slave; in such as are somewhat more refined, she is regarded as a desirable toy; in countries entirely polished, she enjoys juster privileges; the wife being considered as an useful friend, and an agreeable mistress. Her mind is still more prized than her person; and without the improvement of both, she can never expect to become truly agreeable; for her good sense alone can preserve what she has gained by her beauty.

Female beauty, as was said, is always seen to improve about the age of puberty; but, if we should attempt to define in what this beauty consists or what constitutes its perfection, we should find nothing more difficult to determine. Every country has its peculiar way of thinking, in this respect; and even the same country thinks differently, at different times. The ancients had a very different taste from what prevails at present. The eye-brows joining in the middle was considered as a very peculiar grace, by Tibullus, in the enumeration of the charms of his mistress. Narrow foreheads were approved of, and scarce any of the Roman ladies that are celebrated for their other perfections, but are also praised for the redness of their hair. The nose also of the Grecian Venus, was such as would appear at present an actual deformity; as it fell in a straight line from the forehead, without the smallest sinking between the eyes; without which we never see a face at present.

Among the moderns, every country seems to have peculiar ideas of beauty. The Persians admire large eye-brows, joining in the middle; the edges and corners of the eyes are tinged with black, and the size of the head is increased by a great variety of bandages, formed into a turban. In some parts of India, black teeth and white hair, are desired with ardour; and one of the principal employments of the women of Thibet, is to redden the teeth with herbs, and to make their hair white by a certain preparation. The passion for coloured teeth obtains also in China, and Japan; where, to complete their idea of beauty, the object of desire must have little eyes, nearly closed, feet extremely small, and a waist far from being shapely. There are some nations of the American Indians, that flatten the head of their children, by keeping them, while young, squeezed between two boards, so as to make the visage much larger than it would naturally be. Others flatten the head at top; and others make it as round as they possibly can. The inhabitants along the western coasts of Africa, have

a very extraordinary taste for beauty. A far nose, thick lips, and a jet black complexion, are there the most indulgent gifts of Nature. Such, indeed, they are all, in some degree, found to possess. However, they take care, by art, to increase the natural deformities, as they should seem to us; and they have many additional methods of rendering the persons still more frightfully pleasing. The whole body and visage is often scarred with the variety of monstrous figures; which is not done without great pain, and repeated incision; and even sometimes, parts of the body are cut away. But it would be endless to remark the various arts which caprice, or custom, has employed to distort and disfigure the body; in order to render it more pleasing: in fact, every nation, how barbarous soever, seems unsatisfied with the human figure, as Nature has left it, and has its peculiar arts of heightening beauty. Painting, powdering, cutting, boring the nose, and the ears, lengthening the one, and depressing the other, are arts practised in many countries; and, in some degree, admired in all. These arts might have been at first introduced to hide epidemic deformities; custom, by degrees, reconciles them to the view; till, from looking upon them with indifference, the eye at length begins to gaze with pleasure.

## CHAP. V.

### Of the Age of MANHOOD.

THE human body attains its full height during the age of puberty; or, at least a short time after. Some young people cease growing at fourteen, or fifteen; while others continue their growth till two or three and twenty. During this period they are mostly of slender make, their thighs and legs small, and the muscular parts as yet unfilled: but, by degrees, the fleshy fibres augment; the muscles swell, and assume their figure; the limbs become more proportioned, and more round; and, before the age of thirty, the body, in men, has acquired its most perfect symmetry.

In women, the body attains this symmetry much sooner, as with them the age of maturity is much earlier: the muscles, and all the other parts being less strong, less compact, and less solid than those of men, they require less time in coming to perfection; and, as they are less in size, that size is sooner completed. Hence it is, that the persons of women are found to be as complete at twenty, as those of men are found to be at thirty.

The body of a well-shaped man ought to be square, the muscles expressed with boldness, and the lines of the face distinctly marked. In women superior elegance prevails; her form is more delicate and more smooth. Strength and majesty belong to the former, grace and softness are the peculiar embellishments of the latter.

In both, does each part even of their form declare their sovereignty over every living creature. Man supports his body erect; his attitude is that of command; and his face, which is turned towards the heavens, displays the dignity of his station. The image of his soul is painted in his countenance; and the excellence of his nature penetrates through the material form in which it is inclosed. His majestic port, his sedate, and resolute step, announce the superiority of his rank. He touches the earth only with his extremity; and beholds it as if at a disdainful distance. His arms are not given to him for pillars of support; nor, by rendering his hands callous against the ground, does he lose the delicacy of which the hand is the principal organ. The arms and hands are formed for very different purposes; they



they are formed to second every intention of his will, and to perfect the gifts of Nature.

When the soul is at rest, all the features of the visage seem settled in a state of profound tranquility. Their proportion, their union, their harmony, seem to mark the sweet serenity of the mind, and to give a true information of what passes within. When the soul, however, is excited, the human visage becomes a living picture; where the passions are expressed with as much delicacy as energy, where every motion is designed by some correspondent feature, where every impression anticipates the will, and betrays those hidden agitations, that he would often wish to conceal.

It is particularly in the eyes that the passions are painted; and in which we may most readily discover their beginning. The eye seems to belong to the soul more than any other organ; it seems to participate of all its emotions; as well the most soft and tender, as the most violent and tumultuous. These it not only receives, but transmits by sympathy; the observing eye of one catches the secret fire from another; and thus the passion often becomes general.

Such persons as are short-sighted, labour under a particular disadvantage, in this respect. They are, in a manner, entirely cut off from the language of the eyes; and this gives an air of stupidity to the face, which often produces very unfavourable prepossessions. However intelligent we may find such persons, it is with difficulty that we renounce our former prejudices against them. In this manner, we are too much induced to judge of men by their physiognomy; and having perhaps, at first, caught up our judgments prematurely, they mechanically influence us all our lives after. This extends even to the very colour, or the cut of people's cloaths; and we should for this reason be careful, even in such trifling particulars, since an article so paltry as dress goes to make up a part of the total judgment which those we converse with may form to our advantage.

The vivacity, or the languid motion of the eyes, gives the strongest marks to physiognomy; and their colour contributes still more to enforce the expression. The different colours of the eye are the dark-hazle, the light-hazle, the green, the blue, the grey, the whitish-grey, and also the red. These different colours arise from the different colours of the little muscles that serve to contract the pupils; and they are very often found to change colour with disorder, and with age.

Those most frequent are, the hazle and the blue, and very often, both these colours are found in the eyes of the same person. Those eyes which are called black, are only of the dark-hazle, which may be easily seen upon closer inspection; however, those eyes are reckoned the most beautiful where the shade is the deepest; and either in these, or the blue eyes, the fire, which gives to the eye its finest expression, is more distinguishable in proportion to the darkness of the tint. For this reason, the black eyes, as they are called, have the greatest vivacity; but, probably, the blue have the most powerful effects in beauty, as they reflect a greater variety of lights, being composed of more various colours.

This variety, which is found in the colour of the eyes, is peculiar to man, and one or two of the brute creation: but, in general, the colour in any one individual is the same in all the rest. The eyes of oxen are brown; those of sheep of a water colour; those of goats are grey, &c. and it may also be, in general remarked, that the eyes of most white animals are red; thus the rabbit, the ferret, and even in the human race, the white Moor, all have their eyes of a red colour.

Though the eye, when put into motion, seems to

be drawn on one side, yet it only moves round its centre; by which its coloured part moves nearer, or farther from the angle of the eye-lids; or is elevated or depressed. The distance between the eyes is less in man than in any other animal; and in some of these it is so great, that it is impossible that they should ever view the same object with both eyes at once, unless it be at a great distance.

Next to the eyes, the features, which most give a character to the face, are the eye-brows; which being in some measure more apparent than the other features, are most readily distinguished at a distance.

The eye-lashes have an effect, in giving expression to the eye, particularly when long and close; they soften its glances, and improve its sweetness. Man and apes are the only animals that have eye-lashes both upon the upper and lower lids; all other animals want them on the lid below.

The eye-lids serve to guard the ball of the eyes and to furnish it with a proper moisture. The upper lids rise and fall; the lower has scarce any motion; and though their being moved depends on the will, yet it often happens that the will is unable to keep them open, when sleep, or fatigue, oppresses the mind. In birds, and amphibious quadrupeds, the lower lid alone has motion; fishes and insects have no eye-lids whatsoever.

The forehead makes a large part of the face, and a part which chiefly contributes to its beauty. It ought to be justly proportioned; neither too round nor too flat, neither too narrow nor too low, and the hair should come thick upon its extremities. It is known to every body how much the hair tends to improve the face; and how much the being bald serves to take away from beauty. The highest part of the head is that which becomes bald the soonest, as well as that part which lies immediately above the temples; and as for the hair under the temples, and at the back of the head, it is seldom known to fall.

Of all parts, or appendages of the body, the hair is that which is found most different, in different climates; and often, it not only contributes to mark the country, but also the disposition of the man. It is in general thickest where the constitution is strongest; and more glossy and beautiful where the health is most permanent. The ancients held the hair to be a sort of excrement, produced like the nails; the part next the root pushing out that immediately contiguous. But the moderns have found that every hair may be truly said to live, to receive nutriment, to fill and distend itself like the other parts of the body. The roots, they observe, do not turn grey sooner than the extremities, but the whole hair changes colour at once; and we have many instances of persons who have grown grey in one night's time.

The nose is the most prominent feature in the face; but, as it has scarce any motion, and that only in the strongest passions, it rather adds to the beauty, than to the expression of the countenance.

The form of this feature, and its advanced position, are peculiar to the human visage alone. Other animals, for the most part, have nostrils, with a partition between them; but none of them have an elevated nose. Apes themselves have scarce any thing else of this feature, but the nostrils; the rest of the feature lying flat upon the visage, and scarce higher than the cheek-bones.

The mouth and lips, next to the eyes, are found to have the greatest expression. The passions have great power over this part of the face, and the mouth marks its different degrees, by its different forms. The organ of speech still more animates this part, and gives it more life than any other feature in the countenance. The ruby colour of the lips, and the white



white enamel of the teeth, give it such a superiority over every other feature, that it seems to make the principal object of our regards. In fact, the whole attention is fixed upon the lips of the speaker, however rapid his discourse, however various the subject, the mouth takes correspondent situations; and deaf men have been often found to see the force of those reasonings which they could not hear, understanding every word as it was spoken.

The under jaw in man possesses a great variety of motions; while the upper has been thought, by many, to be quite immovable. However, that it moves in man, a very easy experiment will suffice to convince us. If we keep the head fixed with any thing between our teeth, the edge of a table for instance, and then open our mouths, we shall find that both jaws recede from it at the same time; the upper jaw rises, the lower falls, and the table remains untouched between them. The upper jaw has motion as well as the under; and, what is remarkable, it has its proper muscles behind the head, for thus raising and depressing it. Whenever, therefore, we eat, both jaws move at the same time, though very unequally; for the whole head moving with the upper jaw, of which it makes a part, its motions are thus less observable. In the human embryo, the under jaw is very much advanced before the upper. In the adult, it hangs a good deal more backward; and those whose upper and under row of teeth are equally prominent, and strike directly against each other, are what the painters call underhung; and they consider this as a great defect in beauty. The under jaw in a Chinese face falls greatly more backward than with us; and the difference is half an inch, when the mouth is shut naturally. In instances of the most violent passion, the under jaw has often an involuntary quivering motion; and often also, a state of languor produces another, which is that of yawning. Every one knows how very sympathetic this kind of languid motion is; and that for one person to yawn, is sufficient to set all the rest of the company a yawning. A ridiculous instance of this was commonly practised upon the famous M<sup>r</sup> Laurin, one of the professors at Edinburgh. He was very subject to have his jaw dislocated; so that when he opened his mouth wider than ordinary, or when he yawned, he could not shut it again. In the midst of his harangues, therefore, if any of his pupils began to be tired of his lecture, he had only to gape or yawn, and the professor instantly caught the sympathetic affection; so that he thus continued to stand speechless, with his mouth wide open, till his servant, from the next room, was called in to set his jaw again.

When the mind reflects with regret upon some good unattained or lost, it feels an internal emotion, which acting upon the diaphragm, and that upon the lungs, produces a sigh; this when the mind is strongly affected, is repeated; sorrow succeeds these first emotions; and tears are often seen to follow; sobbing is the sigh still more invigorated; and lamentation, or crying, proceeds from the continuance of the plaintive tone of the voice, which seems to implore pity. There is yet a silent agony, in which the mind appears to disdain all external help, and broods over its distresses with gloomy reserve. This is the most dangerous state of mind; accidents, or friendship may lessen the louder kinds of grief; but all remedies for this, must be had from within; and there, despair too often finds the most deadly enemy.

Laughter is a sound of the voice, interrupted and pursued for some continuance. The muscles of the belly, and the diaphragm, are employed in the slightest exertions; but those of the ribs are strongly agitated in the louder; and the head sometimes is thrown backward, in order to raise them with greater

ease. The smile is often an indication of kindness and good-will: it is also often used as a mark of contempt and ridicule.

Blushing proceeds from different passions; being produced by shame, anger, pride, and joy. Paleness is often also the effect of anger, and almost ever attendant on fright and fear. These alterations in the colour of the countenance, are entirely involuntary; all the other expressions of the passions are, in some small degree, under controul; but blushing and paleness, betray our secret purposes; and we might as well attempt to stop them, as the circulation of the blood, by which they are caused.

The whole head, as well as the features of the face, takes peculiar attitudes from its passions: it bends forward, to express humility, shame, or sorrow; it is turned to one side, in languor, or in pity; it is thrown with the chin forward, in arrogance and pride; erect, in self-conceit, and obstinacy; it is thrown backwards in astonishment; and combines its motion to the one side, and the other, to express contempt, ridicule, anger, and resentment. Painters, whose study leads to the contemplation of external forms, are much more adequate judges of these than any naturalist can be; and it is with these a general remark, that no one passion is regularly expressed on different countenances in the same manner; but that grief often sits upon the face like joy; and pride assumes the air of passion. It would be vain, therefore, in words, to express their general effect, since they are often as various as the countenances they sit upon; and in making this distinction nicely, lies all the skill of the physiognomist. In being able to distinguish what part of the face is marked by nature, and what by the mind; what part has been originally formed, and what is made by habit, constitutes this science, upon which the ancients so much valued themselves, and which we at present so little regard. Some, however, of the most acute men among us, have paid great attention to this art; and, by long practice, have been able to give some character of every person whose face they examined. Montaigne is well known to have disliked those men who shut one eye in looking upon any object; and Fielding asserts, that he never knew a person with a steady glavering smile, but he found him a rogue. However, most of these observations, tending to a discovery of the mind by the face, are merely capricious; and Nature has kindly hid our hearts from each other to keep us in good humour with our fellow creatures.

The parts of the head which give the least expression to the face, are the ears; and they are generally found hidden under the hair. These, which are immovable, and make so small an appearance in man, are very distinguishable features in quadrupeds. They serve in them as the principal marks of the passion; the ears discover their joys or their terrors, with tolerable precision; and denote all their internal agitations. The smallest ears, in men, are said to be most beautiful; but the largest are found the best for hearing. There are some savage nations who bore their ears, and so draw that part down, that the tip of the ears are seen to rest upon their shoulders.

The strange variety in the different customs of men, appears still more extravagant in their manner of wearing their beards. Some, and among others the Turks, cut the hair off their heads, and let their beards grow. The Europeans, on the contrary, shave their beards, and wear their hair. The Negroes shave their heads in figures at one time, in stars at another, in the manner of friars; and still more commonly in alternate stripes; and their little boys are shaved in the same manner. The Talapins, of Siam, shave the heads and the eye-brows of such children as are committed to their care.

Every



Every nation seems to have entertained different prejudices, at different times, in favour of one part or another of the beard. Some have admired the hair upon the cheeks on each side, as we see with some low-bred men among ourselves, who want to be fine. Some like the hair lower down; some chuse it curled; and others like it strait. Some have cut it into a peak; and others shave all but the whisker. This particular part of the beard, was highly prized among the Spaniards; till of late, a man without whiskers was considered as unfit for company; and where Nature had denied them, Art took care to supply the deficiency. We are told of a Spanish general, who, when he borrowed a large sum of money from the Venetians, pawned his whisker, which he afterwards took proper care to release. Kingdon assures us, that a considerable part of the religion of the Tartars consists in the management of their whiskers; and that they waged a long and bloody war with the Persians, declaring them infidels, merely because they would not give their whiskers the orthodox cut. The kings of Persia carried the care of their beards to a ridiculous excess, when they chose to wear them matted with gold thread; and even the kings of France of the first race; had them knotted and buttoned with gold. But of all nations, the Americans take the greatest pains in cutting their hair, and plucking their beards. The under part of the beard, and all but the whisker, they take care to pluck up by the roots, so that many have supposed them to have no hair naturally growing on that part; and even Linnæus has fallen into that mistake. Their hair is also cut into bands; and no small care employed in adjusting the whisker. In fact, we have a very wrong idea of savage finery; and are apt to suppose that, like the beasts of the forest, they rise, and are dressed with a shake; but the reverse is true; for no birth-night beauty takes more time or pains in the adorning her person, than they. When the Cherokee kings were over here, they were often three hours in dressing. They never would venture to make their appearance till they had gone through the tedious ceremonies of the toilet; they had their boxes of oil and ochre, their fat, and their perfumes, like the most effeminate beau, and generally took up four hours in dressing, before they considered themselves as fit to be seen. We must not, therefore, consider a delicacy in point of dress, as a mark of refinement, since savages are much more difficult in this particular, than the most fashionable or tawdry European. The more barbarous the people, the fonder of finery. In Europe, the lustre of jewels, and the splendor of the most brilliant colours, are generally given up to women, or to the weakest part of the other sex, who are willing to be contemptibly fine; but in Asia, these trifling fineries are eagerly sought after by every condition of men; and, as the proverb has it, we find the richest jewels in an Ethiop's ear. The passion for glittering ornaments, is still stronger among the absolute barbarians, who often exchange their whole stock of provisions, and whatever else they happen to be possessed of, with our seamen, for a glass bead, or a looking-glass.

Although fashions have arisen in different countries from fancy and caprice, these, when they become general, deserve examination. Mankind have always considered it as a matter of moment, and they will ever continue desirous of drawing the attention of each other, by such ornaments as mark the riches, the power, or the courage of the wearer. The value of those shining stones which have at all times been considered as precious ornaments, is entirely founded upon their scarceness or their brilliancy. It is the same likewise, with respect to those shining metals, the weight of which is so little regarded, when spread over our cloaths. These orna-

ments are rather designed to draw the attention of others, than to add to any enjoyments of our own; and few there are that these ornaments will not serve to dazzle, and who can coolly distinguish between the metal and the man.

All things rare and brilliant, will, therefore, ever continue to be fashionable, while men derive greater advantage from opulence than virtue; while the means of appearing considerable are more easily acquired, than the title to be considered. The first impression we generally make, arises from our dress; and this varies, in conformity to our inclinations, and the manner in which we desire to be considered. The modest man, or he who would wish to be thought so, desires to shew the simplicity of his mind, by the plainness of his dress; the vain man, on the contrary, takes a pleasure in displaying his superiority, and is willing to incur the spectator's dislike, so he does but excite his attention.

Another point of view which men have in dressing, is to increase the size of their figure; and to take up more room in the world than Nature seems to have allotted them. We desire to swell out our cloaths by the stiffness of art, and raise our heels, while we add to the largeness of our heads. How bulky soever our dress may be, our vanities are still more bulky. The largeness of the doctor's wig arises from the same pride, with the smallness of the beau's queue. Both want to have the size of their understanding measured by the size of their heads.

There are some modes that seem to have a more reasonable origin, which is to hide or to lessen the defects of Nature. To take men altogether, there are many more deformed and plain, than beautiful and shapely. The former, as being the most numerous, give law to fashion; and their laws are generally such as are made in their own favour. The women begin to colour their cheeks with red, when the natural roses are faded; and the younger are obliged to submit, though not compelled by the same necessity. In all parts of the world, this custom prevails more or less; and powdering and frizzing the hair, though not so general, seems to have arisen from a similar controul.

But leaving the draperies of the human picture let us return to the figure, unadorned by art. Man's head, whether considered externally, or internally, is differently formed, from that of all other animals, the monkey-kind only excepted, in which there is a striking similitude. There are some differences, however, which we shall take notice of in another place. The bodies of all quadrupede animals are covered with hair; but the head of man seems the part most adorned; and that more abundantly than in any other animal.

There is a very great variety in the teeth of all animals; some have them above and below; others have them in the under jaw only: in some they stand separate from each other; while in some they are continued and united. The palate of some fishes is nothing else but a bony plate studded with points, which perform the offices of teeth. All these substances, in every animal, derive their origin from the nerves, the substance of the nerves hardens by being exposed to the air; and the nerves that terminate in the mouth, being thus exposed, acquire a bony solidity. In this manner, the teeth and nails are formed in man; and in this manner also, the beak, the hoofs, the horns, and the talons of other animals, are found to be produced.

The neck supports the head, and unites it to the body. This part is much more considerable in the generality of quadrupeds, than in man. But fishes, and other animals that want lungs similar to ours, have no neck whatsoever. Birds, in general, have the neck longer than any other kind of animals; those



those of them, which have short claws, have also short necks; those, on the contrary, that have them long, are found to have the neck in proportion. In men, there is a lump upon the wind-pipe, formed by the thyroid cartilage, which is not to be seen in women; an Arabian fable says, that this is a part of the original apple, that has stuck in the man's throat by the way, but that the woman swallowed her part of it down.

The human breast is outwardly formed in a very different manner from that of other animals. It is larger in proportion to the size of the body; and none but man, and such animals as make use of their fore feet as hands, such as monkeys, bats, and squirrels, are found to have those bones called the clavicles, or, as we usually term them, the collar-bones. The breasts in women are larger than in men; however, they seem formed in the same manner; and, sometimes, milk is found in the breasts of men, as well as in those of women. Among animals, there is a great variety in this part of the body. The teats of some, as in the ape and elephant, are like those of men, being but two, and placed on each side of the breast. The teats of the bear amount to four. The sheep has but two, placed between the hinder legs. Other animals, such as the bitch, and the sow, have them all along the belly; and, as they produce many young, they have a great many teats for their support. The form also of the teats varies in different animals; and, in the same animal, at different ages. The bosom in females, seems to unite all our ideas of beauty, where the outline is continually changing, and the gradations are soft and regular.

The graceful fall of the shoulders, both in man and woman, constitute no small part of beauty. In apes, though otherwise made like us, the shoulders are high, and drawn up on each side towards the ears. In man they fall by a gentle declivity; and the more so, in proportion to the beauty of his form. In fact, being high-shouldered, is not without reason considered as a deformity, for we find very sickly persons are always so; and people, when dying, are ever seen with their shoulders drawn up in a surprising manner. The muscles that serve to raise the ribs, mostly rise near the shoulders; and the higher we raise the shoulders, we the more easily raise the ribs likewise. It happens, therefore, in the sickly and the dying, who do not breathe without labour, that to raise the ribs they are obliged to call in the assistance of the shoulders; and thus their bodies assume, from habit, that form which they are so frequently obliged to assume. Women with child also are usually seen to be high-shouldered; for the weight of the inferior parts drawing down the ribs, they are obliged to use every effort to elevate them, and thus they raise the shoulders of course.

The arms of men but very little resemble the fore-feet of quadrupeds, and much less the wings of birds. The ape is the only animal that is possessed of hands and arms; but these are much more rudely fashioned, and with less exact proportion than in men; the thumb not being so well opposed to the rest of the fingers, in their hands, as in ours.

The form of the back is not much different in man from that of other quadrupede animals, only that the reins are more muscular in him, and stronger. The buttock, however, in man, is different from that of all other animals whatsoever. What goes by that name, in other creatures, is only the upper part of the thigh: man being the only animal that supports himself perfectly erect, the largeness of this part is owing to the peculiarity of his position.

Man's feet also are different from those of all other animals, those even of apes not excepted. The

foot of the ape is rather a kind of awkward hand; its toes, or rather fingers, are long; and that of the middle longest of all. This foot also wants the heel, as in man; the sole is narrower, and less adapted to maintain the equilibrium of the body in walking, dancing or running.

The nails are less in man than in any other animal. If they were much longer than the extremities of the fingers, they would rather be prejudicial than serviceable, and obstruct the management of the hand. Such savages as let them grow long make use of them in slaying animals, in tearing their flesh, and such like purposes; however, though their nails are considerably larger than ours, they are by no means to be compared to the hoofs, or the claws of other animals. They may sometimes be seen longer indeed than the claws of any animal whatsoever; as we learn that the nails of some of the learned men in China are longer than their fingers. But these want that solidity which might give force to their exertions; and could never, in a state of nature, have served them for annoyance, or defence.

There is little known exactly with regard to the proportion of the human figure; and the beauty of the best statues is better conceived by observing than by measuring them. The statues of antiquity, which were at first copied after the human form, are now become the models of it; nor is there one man found whose person approaches to those inimitable performances that have thus, in one figure, united the perfections of many. It is sufficient to say that, from being at first models, they are now become originals; and are used to correct the deviations in that form from whence they were taken. We will not, however, pretend to give the proportions of the human body as taken from these, there being nothing more arbitrary, and which good painters themselves so much condemn. Some, for instance, who have studied after these, divide the body into ten times the length of the face; and others into eight. Some pretend to tell us that there is a similitude of proportion in different parts of the body. Thus, that the hand is the length of the face; the thumb the length of the nose; the space between the eyes is the breadth of an eye; that the breadth of the thigh, at thickest, is double that of the thickest part of the leg, and treble the smallest; that the arms extended are as long as the figure is high; that the legs and thighs are half the length of the figure. All this, however, is extremely arbitrary; and the excellence of a shape, or the beauty of a statue, results from the attitude and position of the whole, rather than any established measurements, begun without experience, and adopted by caprice. In general, it may be remarked that the proportions alter in every age, and are obviously different in the two sexes. In woman, the shoulders are narrower, and the neck proportionably longer than in men. The hips also are considerably larger, and the thighs much shorter than in men. These proportions, however, vary greatly at different ages. In infancy the upper parts of the body are much larger than the lower; the legs and thighs do not constitute any thing like half the height of the whole figure; in proportion as the child increases in age, the inferior parts are found to lengthen; so that the body is not equally divided until it has acquired its full growth.

The size of men varies considerably. Men are said to be tall who are from five feet eight inches to six feet high. The middle stature is from five feet five to five feet eight, and these are said to be of small stature who fall under these measures. However, it ought to be remarked, that the same person is always taller when he arises in the morning, than upon going to bed at night; and sometimes there is an inch difference, and often more. Few persons are sensible of this remarkable variation; and some



some say, it was first perceived; in England, by a recruiting officer. He often found that those men whom he had enlisted for soldiers, and answered to the appointed standard at one time, fell short of it when they came to be measured before the colonel at the head quarters. This diminution in their size proceeded from the different times of the day, and the different states of the body when they happened to be measured. If, as was said, they were measured in the morning, after the night's refreshment, they were found to be commonly half an inch, and very often a whole inch taller than if measured after the fatigues of the day; if they were measured when fresh, in the country, and before a long fatiguing march to the regiment, they were found to be an inch taller than when they arrived at their journey's end. All this is now well known among those who recruit for the army; and the reason of this difference of stature is obvious. Between all the joints of the back-bone, which is composed of several pieces, there is a glutinous liquor deposited, which serves, like oil in a machine, to give the parts an easy play upon each other. This lubricating liquor, or synovia, as the anatomists call it, is poured in during the season of repose, and is consumed by exercise and employment; so that in a body, after hard labour, there is scarce any of it remaining; but all the joints grow stiff, and their motion becomes hard and painful. It is from hence, therefore, that the body diminishes in stature. For this moisture being drained away, from between the numerous joints of the back-bone, they lie closer upon each other; and their whole length is thus very sensibly diminished; but sleep, by restoring the fluid, again swells the spaces between the joints, and the whole is extended to its former dimensions.

As the human body is thus often found to differ from itself in size, so it is found to differ in its weight also; and the same person, without any apparent cause, is found to be heavier at one time than another. If, after having eaten an hearty dinner, or having drank hard, the person should find himself thus heavier, it would appear no way extraordinary; but the fact is, the body is very often found heavier some hours after eating an hearty meal, than immediately succeeding it. If, for instance, a person, fatigued by a day's hard labour, should eat a plentiful supper, and then get himself weighed upon going to bed; after sleeping soundly, if he is again weighed, he will find himself considerably heavier than before; and this difference is often found to amount to a pound, or sometimes to a pound and a half. From whence this adventitious weight is derived is not easy to conceive; the body, during the whole night, appears rather plentifully perspiring, than imbibing any fluid; rather losing than gaining moisture; however, we have no reason to doubt but that either by the lungs, or, perhaps, by a peculiar set of pores, it is all this time inhaling a quantity of fluid, which thus increases the weight of the whole body, upon being weighed the next morning.

Although the human body is externally more delicate than any of the quadruped kind, it is, notwithstanding, extremely muscular; and, perhaps, for its size, stronger than that of any other animal. If we should offer to compare the strength of the lion with that of man, we should consider that the claws of this animal give us a false idea of its power; we ascribe to its force what is only the effects of its arms. Those which man has received from Nature are not offensive; happy had art never furnished him with any more terrible than those which arm the paws of the lion.

But there is another manner of comparing the strength of man with that of other animals; namely, of narrow ribs, and a narrow chest, would

by the weights which either can carry. We are assured that the porters of Constantinople, carry but-  
thens of nine hundred pounds weight: Mr. Desaguliers tells us of a man, who, by distributing weights in such a manner as that every part of his body bore its share, he was thus able to raise a weight of two thousand pounds. An horse, which is about seven times our bulk, would be thus able to raise a weight of fourteen thousand pounds, if its strength were in the same proportion. But, the truth is, an horse will not carry upon its back, above a weight of two or three hundred pounds; while a man, of confessedly inferior strength, is thus able to support two thousand. Whence comes this seeming superiority? The answer is obvious. Because the load upon man's shoulder is placed to the greatest advantage; while upon the horse's back, it is placed at the greatest disadvantage. Let us suppose, for a moment, the man standing as upright as possible, under the great load abovementioned. It is obvious that all the bones of his body may be compared to a pillar supporting a building, and that his muscles have scarce any share in this dangerous duty. However, they are not entirely inactive; as man, let him stand never so upright, will have some bending in the different parts of his body. The muscles, therefore, give the bones some assistance, and that with the greatest possible advantage. In this manner, a man has been found to support two thousand weight; but may be capable of supporting a still greater. The manner in which this is done, is by strapping the load round the shoulders of the person, who is to bear it by a machine, something like that by which milk-vessels, or water-buckets are carried. The load being thus placed on a scaffold, on each side, contrived for that purpose, and the man standing erect in the midst, all parts of the scaffold, except that where the man stands, are made to sink; and thus the man maintaining his position, the load, whatever it is, becomes suspended, and the column of his bones may be fairly said to support it. If, however, he should but ever so little give way, he must inevitably drop; and no power of his can raise the weights again. But the case is very different with regard to a load laid upon an horse. The column of the bones there lies a different way; and a weight of five hundred pounds, as we are told, would break the back of the strongest horse that could be found. The great force of an horse and other quadrupeds, is exerted when the load is in such a position as that the column of the bones can be properly applied; which is lengthwise. When, therefore, we are to estimate the comparative strength of an horse, we are not to try what he can carry, but what he can draw; and, in this case, his amazing superiority over man is easily discerned; for one horse can draw a load that ten men cannot move. And in some cases it happens that a draft horse draws the better for being somewhat loaded; for, as the peasants say, the load upon the back keeps him the better to the ground.

There is still another way of estimating human strength by the perseverance and agility of our motions. Men, who are exercised in running, outstrip horses; or at least hold their speed for a longer continuance. In a journey, also, a man will walk down a horse; and, after they have both continued to proceed for several days, the horse will be quite tired, and the man will be fresher than in the beginning. The king's messengers of Isaphan, who are runners by profession, go thirty-six leagues in fourteen hours. Travellers assure us that the Hottentots outstrip lions in the chase; and that the savages who hunt the elk, pursue with such speed, that they at last tire down, and take it. We are told many very surprising things of the great swiftness



of the savages, and of the long journeys they undertake, on foot, through the most craggy mountains, where there are no paths to direct, nor houses to entertain them. They are said to perform a journey of twelve hundred leagues in less than three weeks. But, notwithstanding what travellers report of this matter, we have been assured, from many of our officers and soldiers, who compared their own swiftness with that of the native Americans, during the last war, that although the savages held out, and, as the phrase is, had better bottoms, yet, for a spurt, the Englishmen were more nimble and speedy.

Nevertheless, in general, civilized man is ignorant of his own powers; he is ignorant how much he loses by effeminacy; and what might be acquired by habit and exercise. Here and there, indeed, men are found among us of extraordinary strength; but that strength, for want of opportunity, is seldom called into exertion. Among the ancients it was a quality of much greater use than at present; as in war the same man that had strength sufficient to carry the heaviest armour, had strength sufficient also to strike the most fatal blow. In this case, his strength was at once his protection and his power. We ought not to be surprised, therefore, when we hear of one man terrible to an army, and irresistible in his career, as we find some generals represented in ancient history. But we may be very certain that this prowess was exaggerated by flattery, and exalted by terror. An age of ignorance is ever an age of wonder. At such times, mankind, having no just ideas of the human powers, are willing rather to represent what they wish than what they know; and exalt human strength, to fill up the whole sphere of their limited conceptions. Great strength is an accidental thing; two, or three, in a country, may possess it; and these may have a claim to heroism. But what may lead us to doubt of the veracity of these accounts is, that the heroes of antiquity are represented as the sons of heroes; their amazing strength is delivered down from father to son; and this we know to be contrary to the course of nature. Strength is not hereditary; although titles are: and we are induced to believe that this great tribe of heroes who are all represented as the descendants of heroes, are more obliged to their titles than to their strength, for their characters. With regard to the shining characters in Homer, they are all represented as princes; and as the sons of princes; while we are told of scarce any share of prowess in the meaner men of the army, who are only brought into the field for these to protect, or to slaughter. But nothing can be more unlikely than that those men, who were bred in the luxury of courts, should be strong; while the whole body of the people, who received a plainer and simpler education, should be comparatively weak. Nothing can be more contrary to the general laws of nature, than that all the sons of heroes should thus inherit not only the kingdoms, but the strength of their forefathers; and we may conclude, that they owe the greatest share of their imputed strength rather to the dignity of their stations than the force of their arms; and, like all fortunate princes, their flatterers happened to be believed. In later ages, indeed, we have some accounts of amazing strength, which we can have no reason to doubt of. But in these, nature is found to pursue her ordinary course; and we find their strength accidental. We find these strong men among the lowest of the people, and gradually rising into notice, as this superiority had more opportunity of being seen. Of this number was the Roman tribune, who went by the name of the second Achilles; who, with his own hand is said to have killed, at different times, three hundred of the enemy; and who, treacherously set upon, by twenty-five of his own coun-

tymen, although then past his sixtieth year, killed fourteen of them before he was slain. Of this number was Milo, who, when he stood upright, could not be forced out of his place. Pliny, also, tells us of one Athanarus, who walked across the stage at Rome, loaded with a breast-plate weighing five hundred pounds, and buskins of the same weight. But of all the prodigies of strength, of which we have any accounts in Roman history, Maximian, the emperor, is to be reckoned the foremost. Whatever we are told relative to him is well attested; his character was too exalted not to be thoroughly known; and that very strength, for which he was celebrated, at last procured him no less a reward than the empire of the world. Maximian was above nine feet in height, and the best proportioned man in the whole empire. He was by birth a Thracian; and, from being a simple herdsman, rose through the gradations of office, until he came to be Emperor of Rome. The first opportunity he had of exerting his strength, was in the presence of all the citizens, in the theatre, where he overthrew twelve of the strongest men, in wrestling, and outstript two of the fleetest horses, in running, all in one day. He could draw a chariot loaded, that two strong horses could not move; he could break a horse's jaw with a blow of his fist; and its thigh with a kick. In war he was always foremost, and invincible; happy had it been for him, and his subjects, if, from being formidable to his enemies, he had not become still more so to his subjects; he reigned, for some time, with all the world his enemy; all mankind wishing him dead, yet none daring to strike the blow. As if fortune had resolved that through life he should continue unconquerable; he was killed at last by his own soldiers, while he was sleeping. We have many other instances, in later ages, of very great strength, and not fewer of amazing swiftness; but these, merely corporeal perfections, are now considered as of small advantage, either in war or in peace. The invention of gunpowder has, in some measure, levelled all force to one standard; and has wrought a total change in martial education through all parts of that world. In peace also, the invention of new machines every day, and the application of the strength of the lower animals to the purposes of life, have rendered human strength less valuable. The boast of corporeal force is therefore consigned to savage nations; where those arts not being introduced, it may still be needful; but, in more polite countries, few will be proud of that strength which other animals can be taught to exert to as useful purposes as they.

If we compare the largeness and thickness of our muscles with those of any other animal, we shall find that, in this respect, we have the advantage; and if strength, or swiftness, depended upon the quantity of the muscular flesh alone, in this respect we should be more active and powerful than any other. But this is not the case; a great deal more than the size of the muscles goes to constitute activity, or force; and it is not he who has the thickest legs that can make the best use of them. Those, therefore, who have written elaborate treatises on muscular force, and have estimated the strength of animals by the thickness of their muscles, have been employed to very little purpose. It is, in general, observed that thin and raw-boned men are always stronger and more powerful than such as are seemingly more muscular; as in the former all the parts have better room for their exertions.

Women want much of the strength of men; and in some countries, the stronger sex have availed themselves of this superiority, in cruelly and tyrannically enslaving those who were made with equal pretensions to a share in all the advantages life can bestow. Savage nations oblige their women to a life



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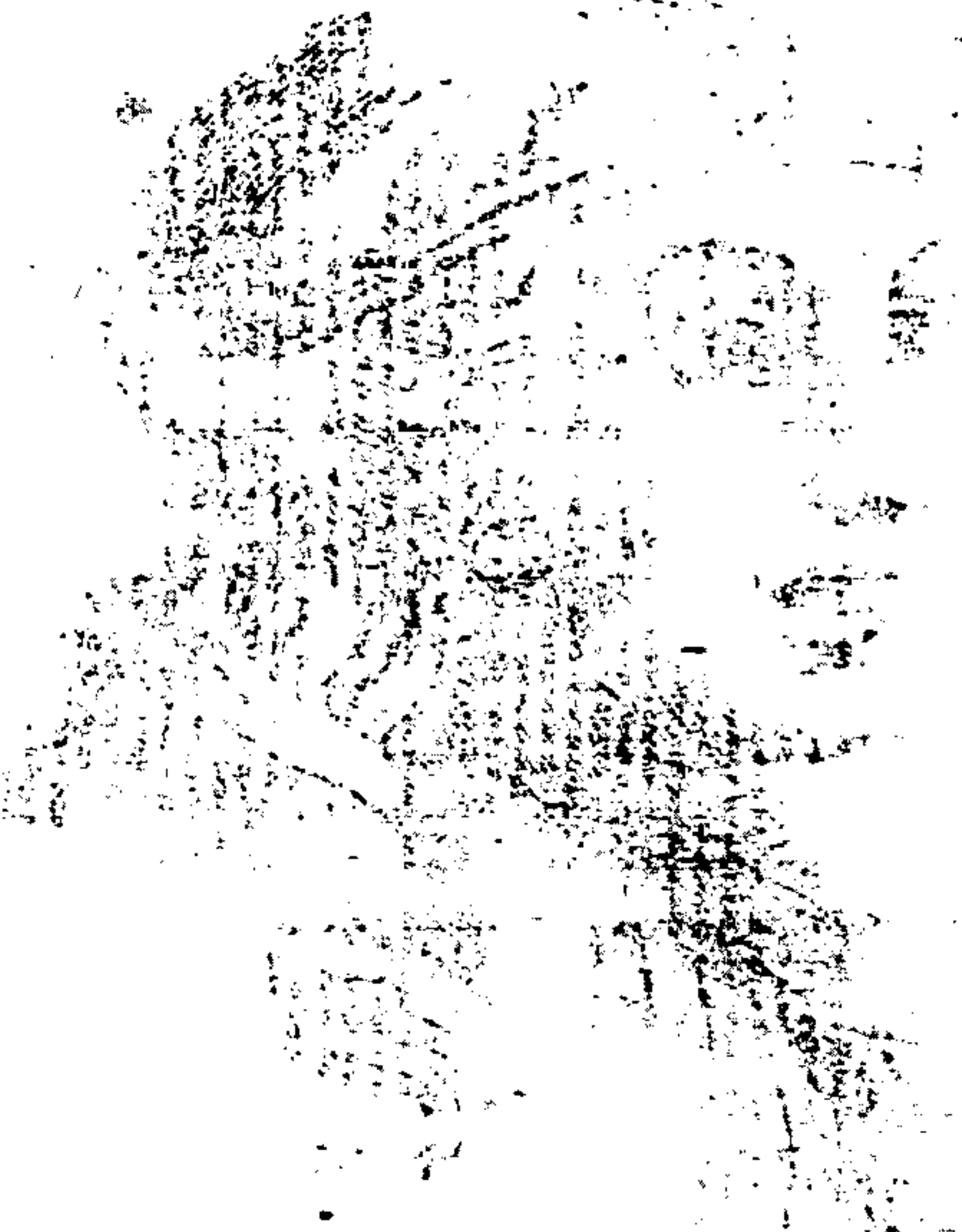
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# NATURAL HISTORY of MAN

## THE PASSIONS



DESIRE



FEAR



HOPE



SORROW



LOVE



RAGE



WEeping



ADMIRATION



life of continual labour; upon them rest all the drudgeries of domestic duty; while the husband, indolently reclined in his hammock, is first served from the fruits of her industry. From this negligent situation he is seldom roused, except by the calls of appetite; when it is necessary, either by fishing or hunting, to make a variety in his entertainments. A savage has no idea of taking pleasure in exercise; he is surprised to see an European walk forward for his amusement, and then return back again. As for his part, he could be contented to remain forever in the same situation, perfectly satisfied with sensual pleasures and undisturbed repose. The women, of these countries, are the greatest slaves upon earth; sensible of their weakness, and unable to resist, they are obliged to suffer those hardships which are naturally inflicted by such as have been taught that nothing but corporeal force ought to give pre-eminence. It is not, therefore, till after some degree of refinement, that women are treated with lenity; and not till the highest degree of politeness, that they are permitted to share in all the privileges of man. The first impulse of savage nature is to confirm their slavery; the next, of half barbarous nations, is to appropriate their beauty; and that, of the perfectly polite, to engage their affections. In civilized countries, therefore, women have united the force of modesty to the power of their natural charms; and thus obtain that superiority over the mind, which they are unable to extort by their strength.

When we come to treat of the different senses, we shall be able to determine what stress is to be laid on the ideas of beauty in general, which we receive from the eyes. In the mean time, and that our description of Man may not be found imperfect, let us examine the human countenance, as it appears among ourselves, when agitated by the Passions.

**DESIRE** may be represented, by the eyebrows being pressed and advanced over the eyes, which shall be more open than ordinary, with the eyeball in the middle full of fire; the nostrils drawn closest next the eyes, the mouth also is more open; than in the foregoing action, the corners drawn back; the tongue may approach upon the edge of the lips, the colour more inflamed than in love; all these motions shewing the agitation of the soul caused by the spirits, which dispose it to desire a good, as convenient for it.

**FEAR.** But if there be no appearance of obtaining what we desire, then instead of hope comes fear or despair; the motion of fear is expressed by the eyebrows a little raised next the nose, the eyebrows sparkling in an unquiet manner, situated in the middle of the eye; the mouth open, and drawn back, and more open at the corners than in the middle; having the under lip more drawn back than the upper; the complexion redder than in love or desire, but not so beautifully inclined to livid; with the lips of the same colour, and dry when love changes fear into jealousy.

**HOPE.** When there is an appearance of obtaining what we desire, that brings forth hope: but the motions of this passion being not so much external as internal, we shall speak but little of them, and only remark, that this passion keeps all the parts of the body suspended, between fear and assurance; in such a manner, that if one part of the eyebrow makes fear, the other makes security; and, in all the parts of the face and body, the motions of these two passions are particularly intermixed.

**SORROW.** As we have said, that sorrow is a disagreeable faintness, by which the soul receives the inconveniency or defect, which presents itself to it by the impression of the brain; so this passion is represented, by motions which seem to mark the

inquietude of the brain, and the dejection of the heart, the eyebrows being more raised in the middle of the forehead than next the temples. He that is troubled with this passion, has his eyeballs dull, the white of the eye inclining to yellow, the eyelids hanging down something swollen, and a livid look round them; the nostrils drawing downwards, the mouth open, the corners thereof drawn down; the head appears carelessly hanging on one of the shoulders, the complexion of a kind of lead colour, and the lips pale and wan.

**SIMPLE LOVE.** The motions of this passion, when it is simple, are very soft and sweet; for the forehead will be smooth, the eyebrows will be a little elevated over the place where the eyeballs shall be turned, the head inclined towards the object of the passion; the eyes may be moderately open, the white very lively and sparkling, and the eyeball being greatly turned toward the object, will appear a little sparkling and elevated; the nose receives no alteration, nor any of the parts of the face, which being only filled with spirits that warm and enliven it, render the complexion fresh and lively, and particularly the cheeks and lips; the mouth may be a little open, the corner a little turned up, the lips will appear moist, and this moistness may be caused by vapours arising from the heart.

**RAGE** hath the same motions as despair, but yet more violent; for the face will be almost black, covered with a cold sweat, the hair at an end, the eyes wandering in a contrary motion, the eyeballs sometimes rolling towards the nose, sometimes back towards the ear, all the parts of the face will be extremely marked and swollen.

**WEeping.** He that weeps, hath his eyebrows hanging down in the middle of the forehead, the eyes almost closed, very wet, and cast down towards the cheeks; the nostrils swelled, all the muscles of the forehead being apparent; the mouth shall be half open, the corners hanging down, and making wrinkles in the cheek; the under lip will appear turned down and pouting out, all the face will appear drawn together and wrinkled, the colour very red, especially about the eyes, eyebrows, nose, mouth, and cheeks.

**ADMIRATION.** As we have said, that admiration is the first and most temperate of all the passions, wherein the heart feels the least disturbance, so the face receives very little alteration; if any, it will be only in the raising of the eyebrows, the ends being parallel, the eye will be a little more open than ordinary, and the ball even between the lids, without motion, being fixed on the object which causes the admiration. The mouth will be open, but will appear without alteration, any more than the other parts of the face: this passion produces only a suspension of motion, to give time to the soul to consider what she has to do; and to consider attentively the object before her, if it be extraordinary. Out of this simple motion of admiration is engendered esteem.

## CHAP. VI.

### Of SLEEP and HUNGER.

**A**S man, in all the privileges he enjoys, and the powers he is invested with, has a superiority over all other animals, so, in his necessities, he seems inferior to the meanest of them all. Nature has brought him into life with a greater variety of wants and infirmities, than the rest of her creatures, unarmed in the midst of enemies. The lion has natural arms; the bear natural cloathing; but man is destitute of all such advantages; and from the superiority of his mind alone, he is to supply the



the deficiency. The number of his wants, however, were merely given, in order to multiply the number of his enjoyments; since the possibility of being deprived of any good, teaches him the value of its possession. Were man born with those advantages which he learns to possess by industry, he would very probably enjoy them with a blunter relish: it is by being naked, that he knows the value of a covering; it is by being exposed to the weather that he learns the comforts of an habitation. Every want thus becomes a means of pleasure, in the redressing; and the animal that has most desires, may be said to be capable of the greatest variety of happiness.

Besides the thousand imaginary wants peculiar to man, there are two, which he has in common with all other animals; and which he feels in a more necessary manner than they. These are the wants of sleep and hunger. Every animal that we are acquainted with, seems to endure the want of these with much less injury to health, than man; and some are most surprisingly patient in sustaining both. The little domestic animals that we keep about us, may often set a lesson of calm resignation, in supporting want and watchfulness, to the boasted philosopher. They receive their pittance at uncertain intervals, and wait its coming with cheerful expectation. We have instances of the dog, and the cat, living, in this manner, without food for several days; and yet still preserving their attachment to the tyrant that oppresses them; still ready to exert their little services for his amusement or defence. But the patience of these is nothing to what the animals of the forest endure. As these mostly live upon accidental carnage, so they are often known to remain without food for several weeks together. Nature, kindly solicitous for their support, has also contracted their stomachs, to suit them for their precarious way of living; and kindly, while it abridges the banquet, lessens the necessity of providing for it. But the meaner tribes of animals are made still more capable of sustaining life without food, many of them remaining in a state of torpid indifference till their prey approaches, when they jump upon and seize it. In this manner, the snake, or the spider, continue, for several months together, to subsist upon a single meal; and some of the butterfly kinds live upon little or nothing. But it is very different with man: his wants daily make their importunate demands; and it is known, that he cannot continue to live many days without eating, drinking, and sleeping.

Hunger is a much more powerful enemy to man than watchfulness, and kills him much sooner. It may be considered as a disorder that food removes; and that would quickly be fatal, without its proper antidote. In fact, it is so terrible to man, that to avoid it he would even encounter certain death; and, rather than endure its tortures, exchanges them for immediate destruction. However, by all accounts, it is much more dreadful in its approaches, than in its continuance; and the pains of a famishing wretch, decrease as his strength diminishes. In the beginning, the desire of food is dreadful indeed, as we know by experience, for there are few who have not in some degree felt its approaches. But, after the first or second day, its tortures become less terrible, and a total insensibility at length comes kindly in to the poor wretch's assistance. A captain of a ship, who was one of six that endured it in its extremities, was the only person that had not lost his senses, when they received accidental relief. His pains at first were so great, as to be often tempted to eat a part of one of the men who died; and which the rest of his crew actually for some time lived upon: he said that, during the continuance of this paroxysm, he found his pains

insupportable; and was desirous, at one time, of anticipating that death which he thought inevitable: but his pains, he said, gradually decreased, after the sixth day, (for they had water in the ship, which kept them alive so long) and then he was in a state rather of langour than desire; nor did he much wish for food, except when he saw others eating; and that for a while revived his appetite, though with diminished importunity. The latter part of the time, when his health was almost destroyed, a thousand strange images rose upon his mind; and everyone of his senses began to bring him wrong information. The most fragrant perfumes appeared to him to have a foetid smell; and every thing he looked at took a greenish hue, and sometimes a yellow. When he was presented with food by the ship's company that took him and his men up, four of whom died shortly after, he could not help looking upon it with loathing, instead of desire; and it was not till after four days, that his stomach was brought to its natural tone; when the violence of his appetite returned, with a sort of canine eagerness.

Thus dreadful are the effects of hunger; and yet, when we come to assign the cause that produces them, we find the subject involved in doubt and intricacy. This longing eagerness is, no doubt, given for a very obvious purpose; that of replenishing the body, wasted by fatigue and perspiration. Were not men stimulated by such a pressing monitor, they might be apt to pursue other amusements, with a perseverance beyond their power; and forget the useful hours of refreshment, in those more tempting ones of pleasure. But hunger makes a demand that will not be refused; and, indeed, the generality of mankind seldom await the call.

Hunger has been supposed by some to arise from the rubbing of the coats of the stomach against each other, without having any intervening substance to prevent their painful attrition. Others have imagined, that its juices, wanting their necessary supply, turn acrid, or, as some say, pungent; and thus fret its internal coats, so as to produce a train of the most uneasy sensations. Boerhaave, who established his reputation in physic, by uniting the conjectures of all those that preceded him, ascribes hunger to the united effect of both these causes; and asserts, that the pungency of the gastric juices, and the attrition of its coats against each other, cause those pains, which nothing but food can remove. These juices continuing still to be separated in the stomach, and every moment becoming more acrid, mix with the blood, and infect the circulation: the circulation being thus contaminated, becomes weaker, and more contracted; and the whole nervous frame sympathizing, an hectic fever and sometimes madness is produced; in which state the faint wretch expires. In this manner, the man who dies of hunger, may be said to be poisoned by the juices of his own body; and is destroyed less by the want of nourishment, than by the vitiated qualities of that which he had already taken.

However this may be, we have but few instances of men dying, except at sea, of absolute hunger; the decline of those unhappy creatures who are destitute of food, at land, being more slow and unperceived. These, from often being in need, and as often receiving an accidental supply, pass their lives between surfeiting and repining; and their constitution is impaired by insensible degrees. Man is unfit for a state of precarious expectation. That share of provident precaution which incites him to lay up stores for a distant day, becomes his torment, when totally unprovided against an immediate call. The lower race of animals, when satisfied, for the instant moment, are perfectly happy: but



but it is otherwise with man; his mind anticipates distress, and feels the pangs of want even before it arrests him. Thus the mind, being continually harassed by the situation, it at length influences the constitution, and unfits it for all its functions. Some cruel disorder, but no way like hunger, seizes the unhappy sufferer; so that almost all those men who have thus long lived by chance, and whose every day may be considered as an happy escape from famine, are known at last to die in reality, of a disorder caused by hunger; but which, in the common language, is often called a broken-heart. The number of such as die in London for want, is much greater than one would imagine, about two thousand in a year.

But how numerous soever those who die of hunger may be, many times greater, on the other hand, are the number of those who die by repletion. It is not the province of the present page to speculate, with the physician, upon the danger of surfeits; or, with the moralist, upon the nauseousness of gluttony: it will only be proper to observe, that as nothing is so prejudicial to health as hunger by constraint, so nothing is more beneficial to the constitution than voluntary abstinence. It was not without reason that religion enjoined this duty; since it answered the double purpose of restoring the health oppressed by luxury, and diminished the consumption of provisions; so that a part might come to the poor. It should be the business of the legislature, therefore, to enforce this divine precept; and thus, by restraining one part of mankind in the use of their superfluities, to consult for the benefit of those who want the necessaries of life. The injunctions for abstinence are strict over the whole Continent; and were rigorously observed, even among ourselves, for a long time after the Reformation. Queen Elizabeth, by giving her commands, upon this head, the air of a political injunction, lessened, in a great measure, and very unwisely, the religious force of the obligation. She enjoined that her subjects should fast from flesh on Fridays and Saturdays; but at the same time declared, that this was not commanded from motives of religion, as if there were any differences in meats, but merely to favour the consumption of fish, and thus to multiply the number of mariners; and also to spare the stock of sheep, which might be more beneficial in another way. In this manner the injunction defeated its own force; and this most salutary law became no longer binding, when it was supposed to come purely from man. How far it may be enjoined in the Scriptures, we will not pretend to say; but this may be asserted, that if the utmost benefit to the individual, and the most extensive advantage to society, serve to mark any institution as of Heaven, this of abstinence may be reckoned among the foremost.

Were we to give an history of the various benefits that have arisen from this command, and how conducive it has been to long life, the instances would fatigue with their multiplicity. It is surprising to what a great age the primitive Christians of the East, who retired from persecution in the deserts of Arabia, continued to live in all the bloom of health, and yet all the rigours of abstemious discipline. Their common allowance, as we are told, for four and twenty hours, was twelve ounces of bread, and nothing but water. On this simple beverage, St. Anthony is said to have lived an hundred and five years; James, the hermit, an hundred and four; Arsenius, tutor to the emperor Arcadius, an hundred and twenty; St. Epiphanius, an hundred and fifteen; Simeon, an hundred and twelve; and Rom-bald, an hundred and twenty. In this manner did these holy temperate men live to an extreme old age, kept chearful by strong hopes, and healthful by moderate labour.

Abstinence which is thus voluntary, may be much more easily supported than constrained hunger. Man is said to live without food for seven days; which is the usual limit assigned him: and, perhaps, in a state of constraint, this is the longest time he can survive the want of it. But, in cases of voluntary abstinence, of sickness, or sleeping, he has been known to live much longer.

In the records of the Tower, there is an account of a Scotchman, imprisoned for felony, who, for the space of six weeks, took not the least sustenance, being exactly watched during the whole time; and for this he received the king's pardon.

When the American Indians undertake long journies, and when, consequently, a stock of provisions sufficient to support them the whole way, would be more than they could carry, in order to obviate this inconvenience, instead of carrying the necessary quantity, they contrive a method of palliating their hunger, by swallowing pills, made of calcined shells and tobacco. These pills take away all appetite, by producing a temporary disorder in the stomach; and, no doubt, the frequent repetition of this wretched expedient, must at last be fatal. By these means, however, they continue several days without eating, chearfully bearing such extremes of fatigue and watching, as would quickly destroy men bred up in a greater state of delicacy. For those arts by which we learn to obviate our necessities, do not fail to unfit us for their accidental encounter.

Upon the whole, therefore, man is less able to support hunger than any other animal; and he is not better qualified to support a state of watchfulness. Indeed, sleep seems much more necessary to him, than to any other creature; as, when awake, he may be said to exhaust a greater proportion of the nervous fluid; and, consequently, to stand in need of an adequate supply. Other animals, when most awake, are but little removed from a state of slumber; their feeble faculties, imprisoned in matter, and rather exerted by impulse than deliberation, require sleep rather as a cessation from motion, than from thinking. But it is otherwise with man; his ideas, fatigued with their various excursions, demand a cessation, not less than the body, from toil; and he is the only creature that seems to require sleep from double motives; not less for the refreshment of the mental than of the bodily frame.

There are some lower animals, indeed, that seem to spend the greatest part of their lives in sleep; but, properly speaking, the sleep of such may be considered as a kind of death; and their waking, a resurrection. Flies, and insects, are said to be asleep, at a time that all the vital motions have ceased; without respiration, without any circulation of their juices, if cut in pieces, they do not awake, nor does any fluid ooze out at the wound. These may be considered rather as congealed than as sleeping animals; and their rest, during winter, rather as a cessation from life, than a necessary refreshment: but in the higher races of animals, whose blood is not thus congealed, and thawed by heat, these all bear the want of sleep much better than man; and some of them continue a long time without seeming to take any refreshment from it whatsoever.

But man is more feeble; he requires its due return; and if it fails to pay the accustomed visit, his whole frame is in a short time thrown into disorder: his appetite ceases; his spirits are dejected; his pulse becomes quicker and harder; and his mind, abridged of its slumbering visions, begins to adopt waking dreams. A thousand strange phantoms arise, which come and go without his will: these, which are transient in the beginning, at last take firm possession of the mind, which yields to their dominion,



dominion, and after a long struggle, runs into confirmed madness. In that horrid state, the mind may be considered as a city without walls, open to every insult, and paying homage to every invader: every idea that then starts with any force, becomes a reality; and the reason, over fatigued with its former importunities, makes no head against the tyrannical invasion, but submits to it from mere imbecillity.

But it is happy for mankind, that this state of inquietude is seldom driven to an extreme; and that there are medicines which seldom fail to give relief. However, man finds it more difficult than any other animal to procure sleep: and some are obliged to court its approaches for several hours together, before they incline to rest. It is in vain that all light is excluded; that all sounds are removed; that warmth and softness conspire to invite it; the restless and busy mind still retains its former activity; and reason that wishes to lay down the reins, in spite of herself, is obliged to maintain them. In this disagreeable state, the mind passes from thought to thought, willing to lose the distinctness of perception, by increasing the multitude of images. At last, when the approaches of sleep are near, every object of the imagination begins to mix with that next it; their outlines become, in a manner, rounder; a part of their distinctions fade away; and sleep, that ensues, fashions out a dream from the remainder.

If then it should be asked from what cause this state of repose proceeds, or in what manner sleep thus binds us for several hours together, we must fairly confess our ignorance, although it is easy to tell what philosophers say upon the subject. Sleep, says one of them, consists in a scarcity of spirits, by which the orifices or pores of the nerves in the brain, through which the spirits used to flow into the nerves, being no longer kept open by the frequency of the spirits, shut of themselves; thus the nerves, wanting a new supply of spirits, become lax, and unfit to convey any impression to the brain. All this, however, is explaining a very great obscurity by somewhat more obscure: leaving, therefore, those spirits to open and shut the entrances to the brain, let us be contented with simply enumerating the effects of sleep upon the human constitution.

In sleep, the whole nervous frame is relaxed, while the heart and the lungs seem more forcibly exerted. This fuller circulation produces also a swelling of the muscles, as they always find who sleep with ligatures on any part of their body. This increased circulation also, may be considered as a kind of exercise, which is continued through the frame; and, by this, the perspiration becomes more copious, although the appetite for food is entirely taken away. Too much sleep dulls the apprehension, weakens the memory, and unfits the body for labour. On the contrary, sleep too much abridged, emaciates the frame, produces melancholy, and consumes the constitution. It requires some care, therefore, to regulate the quantity of sleep, and just to take as much as will completely restore Nature, without oppressing it. The poor, as Otway says, sleep little; forced, by their situation, to lengthen out their labour to their necessities, they have but a short interval for this pleasing refreshment; and we are of opinion, that bodily labour demands a less quantity of sleep than mental. Labourers and artizans are generally satisfied with about seven hours; but we have known some scholars who usually slept nine, and perceived their faculties no way impaired by over-sleeping.

The famous Philip Barrettiere, who was considered as a prodigy of learning at the age of fourteen, was known to sleep regularly twelve hours in

the twenty-four; the extreme activity of his mind, when awake, in some measure called for an adequate alternation of repose: and, we are apt to think, that when students stint themselves in this particular, they lessen the waking powers of the imagination, and weaken its most strenuous exertions. Animals, that seldom think, as was said, can very easily dispense with sleep; and of men, such as think least, will very probably be satisfied with the smallest share. A life of study, it is well known, unfits the body for receiving this gentle refreshment; the approaches of sleep are driven off by thinking: when, therefore, it comes at last, we should not be too ready to interrupt its continuance.

Sleep is, indeed, to some, a very agreeable period of their existence: and it has been a question in the schools, which was most happy, the man who was a beggar by night, and a king by day; or he was a beggar by day, and a king by night? It is given in favour of the nightly monarch, by him who first started the question: for the dream, says he, gives the full enjoyment of the dignity, without its attendant inconveniencies; while, on the other hand, the king, who supposes himself degraded, feels all the misery of his fallen fortune, without trying to find the comforts of his humble situation. Thus, by day, both states have their peculiar distresses: but, by night, the exalted beggar is perfectly blessed, and the king completely miserable. All this, however, is rather fanciful than just; the pleasure dreams can give us, seldom reaches to our waking pitch of happiness: the mind often, in the midst of its highest visionary satisfactions, demands of itself, whether it does not owe them to a dream; and frequently awakes with the reply.

But it is seldom, except in cases of the highest delight, or the most extreme uneasiness, that the mind has power thus to disengage itself from the dominion of fancy. In the ordinary course of its operations, it submits to those numberless fantastic images that succeed each other; and which, like many of our waking thoughts, are generally forgotten. Of these, however, if any, by their oddity, or their continuance, affect us strongly, they are then remembered; and there have been some who felt their impressions so strongly, as to mistake them for realities, and to rank them among the past actions of their lives.

There are others, upon whom dreams seem to have a very different effect; and who, without seeming to remember their impressions the next morning, have yet shewn, by their actions during sleep, that they were very powerfully impelled by their dominion. We have numberless instances of such persons, who, while asleep, have performed many of the ordinary duties to which they had been accustomed when waking; and with a ridiculous industry, have completed by night, what they failed doing by day. We are told, in the German ephemerides, of a young student, who being enjoined a severe exercise by his tutor, went to bed, despairing of accomplishing it. The next morning, awaking, to his great surprize he found the task fairly written out, and finished in his own hand-writing. He was at first, as the account has it, induced to ascribe this strange production to the operations of an infernal agent; but his tutor, willing to examine the affair to the bottom, set him another exercise, still more severe than the former; and took precautions to observe his conduct the whole night. The young gentleman, upon being so severely tasked, felt the same inquietude that he had done on the former occasion; went to bed gloomy and pensive, pondering on the next day's duty, and, after some time, fell asleep. But shortly after, his tutor, who continued to observe him from a place that was concealed, was surprized to see



him get up, and very deliberately go to the table; there he took out pen, ink, and paper, drew himself a chair, and sat very methodically to thinking: it seems, that his being asleep only served to strengthen the powers of his imagination; for he very quickly and easily went through the task assigned him, put his chair aside, and then returned to bed to take out the rest of his nap. What credit we are to give to this account, we will not pretend to determine: but this may be said, that the book from whence it is taken, has some good marks of veracity; for it is very learned, and very dull, and is written in a country noted, if not for truth, at least for want of invention.

The ridiculous history of Arlotto is well known, who has had a volume written, containing a narrative of the actions of his life, not one of which was performed while he was awake. He was an Italian Franciscan friar, extremely rigid in his manners, and remarkably devout and learned in his daily conversation. By night, however, and during his sleep, he played a very different character from what he did by day, and was often detected in very atrocious crimes. He was at one time detected in actually attempting a rape, and did not awake till the next morning, when he was surprised to find himself in the hands of justice. His brothers of the convent often watched him while he went very deliberately into the chapel, and there attempted to commit sacrilege. They sometimes permitted him to carry the chalice and the vestments away into his own chamber, and the next morning amused themselves at the poor man's consternation for what he had done. But of all his sleeping transgressions, that was the most ridiculous, in which he was called to pray for the soul of a person departed. Arlotto, after having very devoutly performed his duty, retired to a chamber which was shewn him, to rest; but there he had no sooner fallen asleep, than he began to reflect that the dead body had got a ring upon one of the fingers, which might be useful to him: accordingly, with a pious resolution of stealing it, he went down, undressed as he was, in a room full of women, and, with great composure, endeavoured to seize the ring. The consequence was, that he was taken before the inquisition for witchcraft, and the poor creature had like to have been condemned, till his peculiar character accidentally came to be known: however, he was ordered to remain for the rest of life in his own convent, and upon no account whatsoever to stir abroad.

What are we to say to such actions as these; or how account for this operation of the mind in dreaming? It should seem, that the imagination, by day, as well as by night, is always employed; and that often, against our wills, it intrudes where it is least commanded or desired. While awake, and in health, this busy principle cannot much delude us: it may build castles in the air, and raise a thousand phantoms before us; but we have every one of the senses alive, to bear testimony to its falsehood. Our eyes shew us that the prospect is not present; our hearing, and our touch, depose against its reality; and our taste and smelling are equally vigilant in detecting the impostor. Reason, therefore, always gives judgment upon the cause; and the vagrant intruder, imagination, is imprisoned, or banished from the mind. But in sleep it is otherwise; having, as much as possible, put our senses from their duty, drawing closed the eyes from seeing, and the ears, taste, and smelling, from their peculiar functions, and having diminished even the touch itself, by all the arts of softness, the imagination is then left not under any large, and to lead the understanding without an opposer. Every inventive idea then becomes a reality; and the mind, not

having one power that can prove the illusion, takes them for truths. As in madness, the senses, from struggling with the imagination, are at length forced to submit, so, in sleep, they seem for a while soothed into the like submission: the smallest violence exerted upon any one of them, however, rouses all the rest in their mutual defence; and the imagination, that had for a while told its thousand falsehoods, is totally driven away, or only permitted to pass under the custody of such as are every moment ready to detect its imposition.

## CHAP. VII. OF SEEING.

HAVING mentioned the senses as correcting the errors of the imagination, and as forcing it, in some measure, to bring us just information, it will naturally follow that we should examine the nature of those senses themselves: we shall thus be enabled to see how far they also impose on us, and how far they contribute to correct each other. Let it be observed, however, that in this we are neither giving a treatise of optics, or phonics, but an history of our own perceptions; and to those we chiefly confine ourselves.

The eyes very soon begin to be formed in the human embryo, and in the chicken also. Of all the parts which the animal has double, the eyes are produced the soonest, and appear the most prominent. It is true, indeed, that in viviparous animals, and particularly in man, they are not so large in proportion, at first, as in the oviparous kinds; nevertheless, they are more speedily developed, when they begin to appear, than any other parts of the body. It is the same with the organ of hearing; the little bones that compose the internal parts of the ear, are entirely formed before the other bones, though much larger, have acquired any part of their growth, or solidity. Hence it appears, that those parts of the body which are furnished with the greatest quantity of the nerves, are the first in forming. Thus the brain, and the spinal marrow, are the first seen begun in the embryo; and in general, it may be said, that wherever the nerves go, or send their branches in great numbers, there the parts are soonest begun, and the most completely finished.

If we examine the eyes of a child some hours, or even some days after its birth, it will be easily discerned that it, as yet, makes no use of them. The humours of the organ not having acquired a sufficient consistence, the rays of light strike but confusedly upon the retina, or expansion of nerves at the back of the eye. It is not till about a month after they are born, that children fix them upon objects; for, before that time, they turn them indiscriminately every where, without appearing to be affected by any. At six, or seven weeks old, they plainly discover a choice in the objects of their attention; they fix their eyes upon the most brilliant colours, and seem peculiarly desirous of turning them towards the light. Hitherto, however, they only seem to fortify the organ for seeing distinctly; but they have still many illusions to correct.

The first great error in vision is, that the eye inverts every object; and it in reality appears to the child, until the touch has served to undeceive it, turned upside down. A second error in vision is, that every object appears double. The same object forms itself distinctly upon each eye; and is consequently seen twice. This error, also, can only be corrected by the touch; and although, in reality, every object we see appears inverted, and double, yet the judgment, and habit, have so often corrected the sense, that we no longer submit to its imposition,



position, but see every object in its just position, the very instant it appears. Were we, therefore, deprived of feeling, our eyes would not only misrepresent the situation, but also the number of all things round us.

To convince us that we see objects inverted, we have only to observe the manner in which images are represented, coming through a small hole, in a darkened room. If such a small hole be made in a dark room so that no light can come in, but through it, all the objects without will be painted on the wall behind, but in an inverted position, their heads downwards. For as all the rays which pass from the different parts of the object without, cannot enter the hole in the same extent which they had in leaving the object, since, if so, they would require the aperture to be as large as the object; and, as each part, and every point of the object, sends forth the image of itself on every side, and the rays, which form these images, pass from all points of the object as from so many centres; so such only can pass through the small aperture as come in opposite directions. Thus the little aperture becomes a centre for the entire object; through which the rays from the upper parts, as well as from the lower parts of it, pass in converging directions; and, consequently, they must cross each other in the central point, and thus paint the objects behind, upon the wall, in an inverted position.

It is, in like manner, easy to conceive, that we see all objects double, whatever our present sensations may seem to tell us to the contrary. For, to convince us of this, we have only to compare the situation of any one object on shutting one eye, and then compare the same situation by shutting the other. If, for instance, we hold up a finger, and shut the right eye, we shall find it hide a certain part of the room; if again reshutting the other eye, we shall find that part of the room visible, and the finger seeming to cover a part of the room that had been visible before. If we open both eyes, however, the part covered will appear to lie between the two extremes. But, the truth is, we see the object our finger had covered, one image of it to the right, and the other to the left; but, from habit, suppose that we see but one image placed between both; our sense of feeling having corrected the errors of sight. And thus, also, if instead of two eyes we had two hundred, we should, at first, fancy the objects increased in proportion, until one sense had corrected the errors of another.

The having two eyes might thus be said to be rather an inconvenience than a benefit, since one eye would answer the purposes of sight as well, and be less liable to illusion. But it is otherwise; two eyes greatly contribute, if not to distinct, at least to extensive vision. When an object is placed at a moderate distance, by the means of both eyes we see a larger share of it than we possibly could with one; the right eye seeing a greater portion of its right side, and the left eye of its correspondent side. Thus both eyes, in some measure, see round the object; and it is this that gives it, in nature, that bold relief, or swelling, with which they appear, and which no painting, how exquisite soever, can attain to. The painter must be contented with shading on a flat surface; but the eyes, in observing nature, do not behold the shading only, but a part of the figure also, that lies behind these very shadings, which gives it that swelling, which painters so ardently desire, but can never fully imitate.

There is another defect, which either of the eyes, taken singly, would have, but which is corrected, by having the organ double. In either eye there is a point, which has no vision whatsoever, so that if one of them only is employed in seeing, there is a part of the object to which it is always totally blind.

This is that part of the optic nerve where its vein and artery run; which being insensible, that point of the object that is painted there must continue unseen. To be convinced of this we have only to try a very easy experiment. If we take three black patches, and stick them upon a white wall, about a foot distant from each other, each about as high as the eye that is to observe them; then retiring six or seven feet back, and shutting one eye, by trying for some time we shall find, that while we distinctly behold the black spots that are to the right and left, that which is in the middle remains totally unseen. Or, in other words, when we bring that part of the eye, where the optic artery runs, to fall upon the object, it will then become invisible. This defect, however, in either eye, is always corrected by both, since the part of the object that is unseen by one, will be very distinctly perceived by the other.

Beside the former defects we can have no idea of distances from the sight, without the help of touch. Naturally every object we see appears to be within our eyes; and a child, who has as yet made but little use of the sense of feeling, must suppose that every thing it sees makes a part of itself. Such objects are only seen more or less bulky as they approach or recede from its eyes; so that a fly that is near will appear larger than an ox at a distance. It is experience alone that can rectify this mistake; and a long acquaintance with the real size of every object, quickly assures us of the distance at which it is seen. The last man in a file of soldiers appears in reality much less, perhaps ten times more diminutive, than the man next to us; however, we do not perceive this difference, but continue to think him of equal stature; for the numbers we have seen thus lessened by distance, and have found, by repeated experience, to be of the natural size, when we come closer, instantly corrects the sense, and every object is perceived with nearly its natural proportion. But it is otherwise, if we observe objects in such situations as we have not had sufficient experience to correct the errors of the eye; if, for instance, we look at men from the top of an high steeple, they, in that case appear very much diminished, as we have not had an habit of correcting the sense in that position.

Although a small degree of reflection will serve to convince us of the truth of these positions, it may not be amiss to strengthen them by an authority which cannot be disputed. Mr. Cheselden having couched a boy of thirteen for a cataract, who had hitherto been blind, and thus at once having restored him to sight, curiously marked the progress of his mind, upon that occasion. This youth, though he had been till then incapable of seeing, yet was not totally blind, but could tell day from night, as persons in his situation always may. He could also, with a strong light, distinguish black from white, and either from the vivid colour of scarlet; however, he saw nothing of the form of bodies; and, without a bright light, not even colours themselves. He was, at first, couched only in one of his eyes; and, when he saw for the first time, he was so far from judging of distances, that he supposed his eyes touched every object that he saw, in the same manner as his hands might be said to feel them. The objects that were most agreeable to him were such as were of plain surfaces and regular figures; though he could as yet make no judgment whatever of their different forms, nor give a reason why one pleased him more than another. Although he could form some idea of colours during his state of blindness, yet that was not sufficient to direct him at present; and he could scarcely be persuaded that the colours he now saw were the same with those he had formerly conceived such erroneous ideas of. He delighted most in green; but black objects, as if giving



ing him an idea of his former blindness, he regarded with horror. He had, as was said, no idea of forms; and was unable to distinguish one object from another, though never so different. When those things were shown him, which he had been formerly familiarized to, by his feeling, he beheld them with earnestness, in order to remember them a second time; but, as he had too many to recollect at once, he forgot the greatest number; and for one he could tell, after feeling, there was a thousand he was totally unacquainted with. He was very much surprised to find that those things and persons he loved best were not the most beautiful to be seen; and even testified displeasure in not finding his parents so handsome as he conceived them to be. It was near two months before he could find that a picture resembled a solid body. Till then he only considered it as a flat surface, variously shadowed; but, when he began to perceive that these kind of shadings actually represented human beings, he then began to examine, by his touch, whether they had not the usual qualities of such bodies, and was greatly surprised to find, what he expected a very unequal surface to be smooth and even. He was then shewn a miniature picture of his father, which was contained in his mother's watch-case, and he readily perceived the resemblance; but asked, with great astonishment, how so large a face could be contained in so small a compass? It seemed as strange to him as if a bushel was contained in a pint vessel. At first, he could bear but a very small quantity of light, and he saw every object much greater than the life; but in proportion as he saw objects that were really large, he seemed to think the former were diminished; and although he knew the chamber where he was contained in the house, yet until he saw the latter, he could not be brought to conceive how an house could be larger than a chamber. Before the operation he had no great expectations from the pleasure he should receive from a new sense; he was only excited by the hopes of being able to read and write; he said, for instance, that he could have no greater pleasure in walking, in the garden, with his sight than he had without it, for he walked there at his ease, and was acquainted with all the walks. He remarked also, with great justice, that his former blindness gave him one advantage over the rest of mankind, which was that of being able to walk in the night, with confidence and security. But, when he began to make use of his new sense, he seemed transported beyond measure. He said that every new object was a new source of delight, and that his pleasure was so great as to be past expression. About a year after, he was brought to Epson, where there is a very fine prospect, with which he seemed greatly charmed; and he called the landscape before him a new method of feeling. He was couched in the other eye, a year after the former, and the operation succeeded equally well: when he saw with both eyes, he said that objects appeared to him twice as large as when he saw but with one; however, he did not see them doubled, or at least he shewed no marks as if he saw them so. Mr. Cheselden mentions instances of many more that were restored to sight in this manner; they all seemed to concur in their perceptions with this youth; and they all seemed particularly embarrassed in learning how to direct their eyes to the objects they wished to observe.

In this manner it is that our feeling corrects the sense of seeing, and that objects which appear of very different sizes, at different distances, are all reduced, by experience, to their natural standard. But not the feeling only, but also the colour, and brightness of the object, contributes, in some measure, to assist us in forming an idea of the distance at which it appears. Those which we see most

strongly marked with light and shade, we readily know to be nearer than those on which the colours are more faintly spread, and that, in some measure, take a part of their hue from the air between us and them. Bright objects also, are seen at a greater distance than such as are obscure, and, most probably, for this reason, that, being less similar in colour to the air which interposes, their impressions are less effaced by it, and they continue more distinctly visible. Thus a black and distant object is not seen so far off as a bright and glittering one, and a fire by night is seen much farther off than by day.

The power of seeing objects at a distance is very rarely equal in both eyes. When this inequality is in any great degree, the person so circumstanced then makes use only of one eye, shutting that which sees the least, and employing the other with all its power. And hence proceeds that awkward look which is known by the name of strabism.

There are many reasons to induce us to think that such as are near-sighted see objects larger than other persons; and yet the contrary is most certainly true, for they see them less. Mr. Buffon informs us that he himself is short-sighted, and that his left eye is stronger than his right. He has very frequently experienced, upon looking at any object, such as the letters of a book, that they appear less to the weakest eye; and that when he places the book, so as that the letters appear double, the images of the left eye, which is strongest, are greater than those of the right, which is the most feeble. He has examined several others, who were in similar circumstances, and has always found that the best eye saw every object the largest. This he ascribes to habit; for near-sighted people being accustomed to come close to the object, and view but a small part of it at a time, the habit ensues, when the whole of an object is seen, and it appears less to them than to others.

Infants having their eyes less than those of adults, must see objects also smaller in proportion. For the image formed on the back of the eye will be large, as the eye is capacious; and infants, having it not so great, cannot have so large a picture of the object. This may be a reason also why they are unable to see so distinctly, or at such distances as persons arrived at maturity.

Old men, on the contrary, see bodies close to them very indistinctly, but bodies at a great distance from them with more precision; and this may happen from an alteration in the coats, or, perhaps, humours of the eye; and not, as is supposed, from their diminution. The cornea, for instance, may become too rigid to adapt itself, and take a proper convexity for seeing minute objects; and its very flatness will be sufficient to fit it for distant vision.

When we cast our eyes upon an object extremely brilliant, or when we fix and detain them too long upon the same object, the organ is hurt and fatigued, its vision becomes indistinct, and the image of the body, which has thus too violently, or too perseveringly employed us, is painted upon every thing we look at, and mixes with every object that occurs. And this is an obvious consequence of the eye taking in too much light, either immediately, or by reflection. Every body exposed to the light, for a time, drinks in a quantity of its rays, which, being brought into darkness, it cannot instantly discharge. Thus the hand, if it be exposed to broad day-light, for some time, and then immediately snatched into a dark room, will appear still luminous, and it will be some time before it is totally darkened. It is thus with the eye; which, either by an instant gaze at the sun, or a steady continuance, upon some less brilliant object, has taken in too much light; its humours are, for a while,



unfit for vision, until that be discharged, and room made for rays of a mild nature. How dangerous the looking upon bright and luminous objects is to the sight, may be easily seen, from such as live in countries, covered for most part of the year with snow, who become generally blind before their time. Travellers who cross these countries, are obliged to wear a crape before their eyes, to save them, which would otherwise be rendered totally unserviceable; and it is equally dangerous in the sandy plains of Africa. The reflection of the light is there so strong that it is impossible to sustain the effect, without incurring the danger of losing one's sight entirely. Such persons, therefore, as read, or write for any continuance, should chuse a moderate light, in order to save their eyes; and, although it may seem insufficient at first, the eye will accustom itself to the shade, by degrees, and be less hurt by the want of light than the excess.

It is, indeed, surprising how far the eye can accommodate itself to darkness, and make the best of a gloomy situation. When first taken from the light, and brought into a dark room, all things disappear; or, if any thing is seen, it is only the remaining radiations that still continue in the eye. But, after a very little time, when these are spent, the eye takes the advantage of the smallest ray that happens to enter; and this alone would, in time, serve for many of the purposes of life. There was a gentleman of great courage and understanding, who was a major under King Charles the First. This unfortunate man sharing in his master's misfortunes, and being forced abroad, ventured at Madrid to do his king a signal service; but, unluckily, failed in the attempt. In consequence of this, he was instantly ordered to a dark and dismal dungeon, into which the light never entered, and into which there was no opening but by a hole at the top, down which the keeper put his provisions, and presently closed it again on the other side. In this manner the unfortunate loyalist continued for some weeks, distressed and disconsolate; but, at last, began to think he saw some little glimmering of light. This internal dawn seemed to increase from time to time, so that he could not only discover the parts of his bed, and such other large objects, but, at length, he even began to perceive the mice that frequented his cell; and saw them as they ran about the floor, eating the crumbs of bread that happened to fall. After some months confinement he was at last set free; but, such was the effect of the darkness upon him, that he could not for some days venture to leave his dungeon, but was obliged to accustom himself by degrees to the light of the day.

## CHAP. VIII.

### OF HEARING.

AS the sense of hearing, as well as of sight, gives us notice of remote objects, so like that, it is subject to similar errors, being capable of imposing on us upon all occasions, where we cannot rectify it by the sense of feeling. We can have from it no distinct intelligence of the distance from whence a sounding body is heard; a great noise far off, and a small one very near, produces the same sensation; and, unless we receive information from some other sense, we can never distinctly tell whether the sound be a great or a small one. It is not till we have learned, by experience, that the particular sound which is heard, is of a peculiar kind, then we can judge of the distance from whence we hear it. When we know the tone of the bell, we can then judge how far it is from us.

Every body that strikes against another produces

a sound, which is simple, and but one in bodies which are not elastic, but which is often repeated in such as are. If we strike a bell, or a stretched string, for instance, which are both elastic, a single blow produces a sound, which is repeated by the undulations of the sonorous body, and which is multiplied as often as it happens to undulate, or vibrate. These undulations each strike their own peculiar blow; but they succeed so fast, one behind the other, that the ear supposes them one continued sound; whereas in reality, they make many. A person who should, for the first time, hear the toll of the bell, would very probably, be able to distinguish these breaks of sound; and, in fact, we can readily ourselves perceive an intension and remission in the sound.

In this manner, sounding bodies are of two kinds; those unelastic ones, which being struck, return but a single sound; and those more elastic returning a succession of sounds, which uniting together form a tone. This tone may be considered as a great number of sounds, all produced one after the other, by the same body, as we find in a bell, or the string of an harpsichord, which continues to sound for some time after it is struck. A continuing tone may be also produced from a nonelastic body, by repeating the blow quick and often, as when we beat a drum, or when we draw a bow along the string of a fiddle.

Considering the subject in this light, if we should multiply the number of blows, or repeat them at quicker intervals upon the sounding body, as upon the drum, for instance, it is evident that this will have no effect in altering the tone; it will only make it either more even or more distinct. But it is otherwise, if we increase the force of the blow; if we strike the body with double weight, this will produce a tone twice as loud as the former. If, for instance, we strike a table with a switch, this will be very different from the sound produced by striking it with a cudgel. From hence, therefore, we may infer, that all bodies give a louder and graver tone, not in proportion to the number of times they are struck, but in proportion to the force that strikes them. And, if this be so, those philosophers who make the tone of a sonorous body, of a bell, or the string of an harpsichord, for instance, to depend upon the number only of its vibrations, and not the force, have mistaken what is only an effect for a cause. A bell, or an elastic string can only be considered as a drum beaten; and the frequency of the blows can make no alteration whatever in the tone. The largest bells, and the longest and thickest strings, have the most forceful vibrations; and, therefore, their tones are the most loud and the most grave.

To know the manner in which sounds thus produced become pleasing, it must be observed, no one continuing tone, how loud or swelling soever, can give us satisfaction; we must have a succession of them, and those in the most pleasing proportion. The nature of this proportion may be thus conceived. If we strike a body incapable of vibration with a double force, or, what amounts to the same thing, with a double mass of matter, it will produce a sound that will be doubly grave. Music has been said, by the ancients, to have been first invented from the blows of different hammers on an anvil. Suppose then we strike an anvil with an hammer of one pound weight, and again with an hammer of two pounds, it is plain that the two pound hammer will produce a sound twice as grave as the former. But if we strike with a two pound hammer, and then with a three pound, it is evident that the latter will produce a sound one third more grave than the former. If we strike an anvil with a three pound hammer, and then with a four pound,



it will likewise follow that the latter will be a quarter part more grave than the former. Now, in the comparing between all those sounds, it is obvious that the difference between one and two is more easily perceived than between two and three, three and four, or any numbers succeeding in the same proportion. The succession of sounds will be, therefore, pleasing in proportion to the ease with which they may be distinguished. That sound which is double the former, or, in other words, the octave to the preceding tone, will of all others be the most pleasing. The next to that, which is as two to three, or, in other words, the third, will be most agreeable. And thus universally, those sounds whose difference may be most easily compared are the most agreeable.

Musicians, therefore, have contented themselves with seven different proportions of sound, which are called notes, and which sufficiently answer all the purposes of pleasure. Not but that they might adopt a greater diversity of proportions; and some have actually done so; but, in these, the differences of the proportion are so imperceptible, that the ear is rather fatigued than pleased in making the distinction. In order, however, to give variety, they have admitted half tones; but, in all the countries where music is yet in its infancy, they have rejected such; and they can find music in none but the obvious. The Chinese, for instance, have neither flats nor sharps in their music; but the intervals between their other notes, are in the same proportion with ours.

Many more barbarous nations have their peculiar instruments of music; and, what is remarkable, the proportion between their notes is in all the same as in ours. This is not the place for entering into the nature of these sounds, their effects upon the air, or their consonances with each other. We are not now giving an history of sound, but of human perception.

All countries are pleased with music; and, if they have not skill enough to produce harmony, at least they seem willing to substitute noise. Without all question, noise alone is sufficient to operate powerfully on the spirits; and, if the mind be already predisposed to joy, we have seldom found noise fail of increasing it into rapture. The mind feels a kind of distracted pleasure in such powerful sounds, braces up every nerve, and riots in the excess. But, as in the eye, an immediate gaze upon the sun will disturb the organ, so, in the ear, a loud, unexpected noise, disorders the whole frame, and sometimes disturbs the sense ever after. The mind must have time to prepare for the expected shock, and to give its organs the proper tension for its arrival.

Musical sounds, however, seem of a different kind. These are generally most pleasing, which are most unexpected. It is not from bracing up the nerves, but from the grateful succession of the sounds, that these become so charming. There are few, how indifferent soever, but have at times felt their pleasing impression; and, perhaps, even those who have stood out against the powerful persuasion of sounds, only wanted the proper tune, or the proper instrument to allure them.

The ancients give us a thousand strange instances of the effects of music, upon men and animals. The story of Arion's harp, that gathered the dolphins to the ship's side, is well known; and, what is remarkable, Schotteus assures us, that he saw a similar instance of fishes being allured by music. They tell us of diseases that have been cured, unchastity corrected, seditions quelled, passions removed, and sometimes excited even to madness. Doctor Wallis has endeavoured to account for these surprising effects, by ascribing them to the novelty

of the art; but we can scarce hesitate to impute them to the exaggeration of their writers. They are as hyperbolic in the effects of their oratory; and yet, we well know, there is nothing in the orations which they have left us, capable of exciting madness, or of raising the mind to that ungovernable degree of fury which they describe. As they have exaggerated, therefore, in one instance, we may naturally suppose, that they have done the same in the other; and, indeed, from the few remains we have of their music, collected by Meibomius, one might be apt to suppose, there was nothing very powerful in what is lost. Nor does any one of the ancient instruments, such as we see them represented in statues, appear comparable to our fiddle.

However this be, we have many odd accounts, not only among them, but the moderns, of the power of music; and it must not be denied, but that, on some particular occasions, musical sounds may have a very powerful effect. We have seen all the horses and cows in a field, where there were above an hundred, gather round a person that was blowing the French horn, and seeming to testify an awkward kind of satisfaction. Dogs are well known to be very sensible of different tones in music; and we have sometimes heard them sustain a very ridiculous part in a concert, where their assistance was neither expected nor desired.

We are told, of Henry IV. of Denmark, that being one day desirous of trying in person whether a musician who boasted that he could excite men to madness, was not an impostor, he submitted to the operation of his skill: but the consequence was much more terrible than he expected; for, becoming actually mad, he killed four of his attendants in the midst of his transports. A contrary effect of music we have, in the cure of a madman of Alais, in France, by music. This man, who was a dancing-master, after a fever of five days grew furious, and so ungovernable that his hands were obliged to be tied to his sides: what at first was rage, in a short time was converted into silent melancholy, which no arts could exhilarate, nor no medicines remove. In this sullen and dejected state, an old acquaintance accidentally came to enquire after his health; he found him sitting up in bed, tied, and totally regardless of every external object round him. Happening, however, to take up a fiddle that lay in the room, and touching a favourite air, the poor madman instantly seemed to brighten up at the sound; from a recumbent posture, he began to sit up; and as the musician continued playing, the patient seemed desirous of dancing to the sound: but he was tied, and incapable of leaving his bed, so that he could only humour the tune with his head, and that part of his arms which were at liberty. Thus the other continued playing, and the dancing-master practised his own art, as far as he was able, for about a quarter of an hour, when suddenly falling into a deep sleep, in which his disorder came to a crisis, he awaked perfectly recovered.

A thousand other instances might be added, equally true: let it suffice to add one more, which is not true; we mean that of the tarantula. Every person who has been in Italy, now well knows, that the bite of this animal, and its being cured by music, is all a deception. When strangers come into that part of the country, the country people are ready enough to take money for dancing to the tarantula. A gentleman had a servant who suffered himself to be bit; the wound, which was little larger than the puncture of a pin, was uneasy for a few hours, and then became well without any farther assistance. Some of the country people, however, still make a tolerable livelihood of the credu-



ity of strangers, as the musician finds his account in it, not less than the dancer.

Sounds, like light, are not only extensively diffused, but are frequently reflected. The laws of this reflection, it is true, are not as well understood as those of light; all we know is, that sound is principally reflected by hard bodies; and their being hollow also, sometimes increases the reverberation. No art, however, can make an echo; and some, who have bestowed great labour and expence upon such a project, have only erected shapeless buildings whose silence was a mortifying lecture upon their presumption.

The internal cavity of the ear seems to be fitted up for the purposes of echoing sound with the greatest precision. This part is fashioned out in the temporal bone, like a cavern cut into a rock. In this the sound is repeated and articulated; and, as some anatomists tell us, (for we have as yet but very little knowledge on this subject) is beaten against the tympanum, or drum of the ear, which moves four little bones joined thereto; and these move and agitate the internal air which lies on the other side; and lastly, this air strikes and affects the auditory nerves, which carry the sound to the brain.

One of the most common disorders in old age is deafness; which probably proceed from the rigidity of the nerves in the labyrinth of the ear. This disorder also, sometimes proceeds from a stoppage of the wax, which art may easily remedy. In order to know whether the defect be an internal or an external one; let the deaf person put a repeating watch into his mouth; and if he hears it strike, he may be assured that his disorder proceeds from an external cause, and is, in some measure, curable: for there is a passage for the ears into the mouth, by what anatomists call the eustachian tube; and by this passage, people often hear sounds, when they are utterly without hearing through the larger channel: and this also is the reason that we often see persons who listen with great attention, hearken with their mouths open, in order to catch all the sound at every aperture.

It often happens, that persons hear differently with one ear from the other; and it is generally found that these have what is called, by musicians, a bad ear. Mr. Buffon, who has made many trials upon persons, of this kind, always found that their defect in judging properly of sounds, proceeded from the inequality of their ears; and receiving by both, at the same, unequal sensations, they form an unjust idea. In this manner, as those people hear false, they also, without knowing it, sing false. Those persons also frequently deceive themselves with regard to the side from whence the sound comes, generally supposing the noise to come on the part of the best ear.

Such as are hard of hearing find the same advantage in the trumpet made for this purpose, that short-sighted persons do from glasses. These trumpets might be easily improved, so as to increase sounds, in the same manner that the telescope does objects: however, they could be used to advantage only in a place of solitude and stillness, as the neighbouring sounds would mix with the more distant, and the whole would produce in the ear nothing but tumult and confusion.

Hearing is a much more necessary sense to man than to animals. With these it is only a warning against danger, or an encouragement to mutual assistance. In man, it is the source of most of his pleasures; and without which, the rest of his senses would be of little benefit. A man born deaf, must necessarily be dumb; and his whole sphere of knowledge must be bounded only by sensual objects. We have an instance of a young man who, being

born deaf, was restored, at the age of twenty-four, to perfect hearing: the account is given in the Memoirs of the Academy of Sciences, 1703, page 180. A young man of the town of Chartres, between the age of twenty-three and twenty-four, the son of a tradesman, and deaf and dumb from his birth, began to speak all of a sudden, to the great astonishment of the whole town. He gave them to understand that, about three or four months before he had heard the sound of bells for the first time, and was greatly surprised at this new and unknown sensation. After some time a kind of water issued from his left ear, and he then heard perfectly well with both. During these three months, he was sedulously employed in listening, without saying a word; and accustomed himself to speak softly, so as not to be heard, the words pronounced by others. He laboured hard also in perfecting himself in the pronunciation, and in the ideas attached to every sound. At length, having supposed himself qualified to break silence, he declared, that he could now speak, although as yet but imperfectly. Soon after, some able divines questioned him concerning his ideas of his past state; and principally with respect to God, his soul, the morality or turpitude of actions. The young man, however, had not driven his solitary speculations into that channel. He had gone to mass indeed with his parents, had learned to sign himself with the cross, to kneel down and assume all the grimaces of a man that was praying; but he did all this without any manner of knowledge of the intention or the cause; he saw others do the like, and that was enough for him; he knew nothing even of death, and it never entered into his head; he led a life of pure animal instinct, entirely taken up with sensible objects; and such as were present, he did not seem even to make as many reflections upon them, as might reasonably be expected from his improving situation; and yet, the young man, was not in want of understanding. But the understanding of a man deprived of all commerce with others, is so very confined, that the mind is, in some measure totally under the controul of its immediate sensations.

Notwithstanding, it is very possible to communicate ideas to deaf men, which they previously wanted, and even give them very precise notions of some abstract subjects, by means of signs, and of letters. A person born deaf, may, by time, and sufficient pains, be taught to write and read, to speak, and, by the motions of the lips, to understand what is said to him: however, it is probable that, as most of the motions of speech are made within the mouth by the tongue, the knowledge from the motion of the lips, is but very confined: nevertheless, a gentleman thus taught has been conversed with, and in all the commonly occurring questions, and the usual salutations, he was ready enough, merely by attending to the motion of the lips alone; but when he was spoke to for a short continuance, he was totally at a loss, although he understood the subject, when written, extremely well. Persons taught in this manner, were at first considered as prodigies; but there have been so many instances of success of late, and so many are skilful in the art of instructing in this way, that, though still a matter of some curiosity, it ceases to be an object of wonder.

## CHAP. IX.

### OF SMELLING, FEELING, and TASTING.

**A**n animal may be said to fill up that sphere which he can reach by his senses; and is actually large in proportion to the sphere to which its organ



organ extends far beyond the organs of sight and touch, and is a wide circle, that of hearing, though less widely diffused, nevertheless extends his power to the sense of smelling, and is more contracted to taste, and the taste and touch are the most confined of all. Thus man enjoys very distant objects, but with one sense only; more nearly, he brings two senses to bear upon them; his sense of smelling assists the other two, at its own distance, and of such objects, as man, he is said to be an perfect possessor, to show that it is not only to the sense of smell, but to the sense of touch, and to the sense of taste, that he is indebted for his knowledge of the world.

Each sense, however, the more it acts at a distance, the more capable it is of making combinations; and is, consequently, the more improvable. Refined imaginations, and men of strong minds, take more pleasure, therefore, in improving the lights of the distant senses, than in enjoying such as are scarce capable of improvement.

By combining the objects of the extensive senses, all the arts of poetry, painting, and harmony, have been discovered; but the closer senses, if we may so call them, such as smelling, tasting, and touching, are, in some measure, as simple as they are limited, and admit of little variety. The man of imagination makes a great and artificial happiness, by the pleasure of altering and combining; the sensualist just stops where he began, and makes only those pleasures which he cannot improve. The sensualist is contented with those enjoyments, that are already made to his hand; but the man of pleasure is best pleased with growing happiness.

Of all the senses, perhaps, there is not one in which man is more inferior to other animals than in that of smelling. With man, it is a sense that acts in a narrow sphere, and disgusts almost as frequently as it gives him pleasure. With many other animals it is diffused to a very great extent; and never seems to offend them. Dogs not only trace the steps of other animals, but also discover them by the scent, at a very great distance, and while they are thus exquisitely sensible of all smells, they seem no way disgusted by any. But, although this sense is in general, so very inferior in man, it is much stronger in those nations that abstain from animal food, than among Europeans. The Bramins of India have a power of smelling equal to what it is in most other creatures. They can smell the water which they drink, that to us seems quite inodorous; and have a word in their language, which denotes a country of fine water. We are told, also, that the Negroes of the Antilles, by the smell alone, can distinguish between the footsteps of a Frenchman and a Negro. It is possible, therefore, that we may dull this organ by our luxurious way of living; and sacrifice to the pleasures of taste those which might be received from perfume.

However, it is a sense that we can, in some measure, dispense with; and we have known many that wanted it entirely, with but very little inconvenience from its loss. In a state of nature it is said to be useful in guiding us to proper nourishment, and deterring us from that which is unwholesome; but, in our present situation, such information is but little wanted; and, indeed, but little attended to. In fact, the sense of smelling gives us very often false intelligence. Many things that have a disagreeable odour are, nevertheless, wholesome, and pleasant to the taste; and such as make eating an art, seldom think it fit to please the appetite till it begins to offend the nose. On the other hand, there are many things that smell most gratefully, and yet are noxious, or fatal to the constitution. Some physicians think that perfumes, in general, are unwholesome; that they relax the nerves, produce head-aches, and even retard digestion. The medicinal apple, which

is known to be deadly poison, is possessed of the most grateful odour. Some of those mineral vapours that are often found fatal, in the stomach, smell like the sweetest flowers, and continue thus to flatter till they destroy. This sense, therefore, as it should seem, was never meant to direct us in the choice of food, but appears rather as an attendant, than a necessary pleasure.

Indeed, if we examine the natives of different countries, or even different natives of the same, we shall find no pleasure in which they differ so widely as that of smelling. Some persons are pleased with the smell of a rose, while we have known others that could not abide to have it approach them. The savage nations are highly delighted with the smell of allspice, which is to us the most nauseous stink in nature. It would, in a manner, seem that our delight in perfumes was made by habit; and that a very little industry could bring us totally to invert the perception of odours.

Thus much is certain, that many bodies which at one distance are an agreeable perfume, when nearer are a most disagreeable odour. Musk, and amber-grease, in small quantities, are considered by most persons as highly fragrant; and yet, when in larger masses, their scent is insufferable. From a mixture of two bodies, each whereof is, of itself, void of all smell, a very powerful smell may be drawn. Thus, by grinding quick-lime with sal ammoniac, may be produced a very foetid mixture. On the contrary, from a mixture of two bodies, that are separately disagreeable, a very pleasant aromatic odour may be gained. A mixture of aqua fortis with spirit of wine produces this effect. But not only the alterations of bodies, by each other, but the smallest change in us, makes a very great alteration in this sense, and frequently deprives us of it totally. A slight cold often hinders us from smelling, and as often changes the nature of odours. Some persons, from disorder, retain an incurable aversion to those smells which most pleased them before; and many have been known to have an antipathy to some animals, whose presence they instantly perceive by the smell. From all this, therefore, the sense of smelling appears to be an uncertain monitor, easily disordered, and not much missed when totally wanting.

The sense most nearly allied to smelling is that of tasting. This, some have been willing to consider merely as a nearer kind of touch, and have undertaken to account, in a very mechanical manner, for the difference of flavours. Such bodies, say they, as are pointed, happening to be applied to the papillae of the tongue, excite a very powerful sensation, and give us the idea of saltness. Such, on the contrary, as are of a rounder figure, slide smoothly along the papillae, and are perceived to be sweet. In this manner they have, with minute labour, gone through the variety of imagined forms in bodies, and have given them as imaginary effects. All we can precisely determine upon the nature of tastes is, that the bodies to be tasted must be either somewhat moistened, or, in some measure, dissolved by the saliva, before they can produce a proper sensation: when both the tongue itself, and the body to be tasted, are extremely dry, no taste whatever ensues. The sensation is then changed; and the tongue, instead of tasting can only be said, like any other part of the body, to feel the object.

It is for this reason, that children have a stronger relish of dainties than those who are more advanced in life. This organ with them, from the greater moisture of their bodies, is kept in greater perfection; and is, consequently, better adapted to perform its functions. Every person remembers how great a pleasure he found in sweets while a child; but his taste growing more obtuse, with age, he is obliged to



to use artificial means to excite it. It is then that he is found to call in the assistance of poignant sauces, and strong relishes, of salts and aromatics; all which the delicacy of his tender organ, in childhood, were unable to endure. His taste grows callous to the natural relishes; and is artificially formed to others more unnatural; so that the highest epicure may be said to have the most depraved taste; as it is owing to the bluntness of his organs that he is obliged to have recourse to such a variety of expedients, to gratify his appetite.

As smells are often rendered agreeable by habit, so also tastes may be. Tobacco, and coffee, so pleasing to many, are yet, at first, very disagreeable to all. It is not without perseverance that we begin to have a relish for them; we force nature so long, that what was constraint, in the beginning, at last becomes inclination.

The grossest, and yet, the most useful of all the senses, is that of feeling. We are often seen to survive under the loss of the rest; but of this we can never be totally deprived, but with life. Although this sense is diffused over all parts of the body, yet it most frequently happens that those parts which are most exercised in touching, acquire the greatest degree of accuracy. Thus the fingers, by long habit, become greater masters in the art than any others, even where the sensation is more delicate and fine. It is from this habit, therefore, and their peculiar formation, and not, as is supposed, from their being furnished with a greater quantity of nerves, that the fingers are thus perfectly qualified to judge of forms. Blind men, who are obliged to use them much oftner, have this sense much finer; so that the delicacy of the touch arises rather from the habit of constantly employing the fingers, than from any fancied nervousness in their conformation.

All animals that are furnished with hands, seem to have more understanding than others. Monkeys have so many actions, like those of men, that they appear to have similar ideas of the form of bodies. All other creatures, deprived of hands, can have no distinct ideas of the shape of the objects, by which they are surrounded, as they want this organ, which serves to examine and measure their forms, their risings and depressions. A quadrupede probably conceives as erroneous an idea of any thing near him, as a child would of a rock, or a mountain, that it beheld at a distance. It may be for this reason, that we often see them frightened at things with which they ought to be better acquainted. Fishes, whose bodies are covered with scales, and who have no organs for feeling, must be the most stupid of all animals. Serpents, that are likewise destitute, are yet, by winding round several bodies, better capable of judging of their form. All these, however, can have but very imperfect ideas from feeling; and we have already seen, when deprived of this sense, how little the rest of the senses are to be relied on.

The feeling therefore, is the guardian, the judge, and the examiner of all the rest of the senses. It establishes their information, and detects their errors. All the other senses are altered by time, and contradict their former evidence; but the touch still continues the same; and though extremely confined in its operations, yet it is never found to deceive. The universe, to a man who had only used the rest of his senses, would be but a scene of illusion; every object misrepresented, and all its properties unknown. Mr. Buffon has imagined a man just newly brought into existence, describing the illusion of his first sensations, and pointing out the steps by which he arrived at reality. He considers him as just created, and awaking amidst the productions of Nature; and to animate the narrative still more strongly, has made his philosophical man a speaker.

The reader will, no doubt, recollect Adam's speech in Milton, as being similar. One treats the subject more as a poet, the other more as a philosopher. The philosopher's man describes his first sensation in the following manner:

"I well remember that joyful anxious moment when I first became acquainted with my own existence. I was quite ignorant of what I was, how I was produced, or from whence I came. I opened my eyes: what an addition, to my surprize! the light of the day, the azure vault of heaven, the verdure of the earth, the chrystal of the waters, all employed me at once, and animated and filled me with inexpressible delight. I at first imagined that all those objects were within me, and made a part of myself.

Impressed with this idea, I turned my eyes to the sun; its splendor dazzled and overpowered me: I shut them once more; and, to my great concern, I supposed that, during this short interval of darkness, I was again returning to nothing.

Afflicted, seized with astonishment, I pondered a moment on this great change, when I heard a variety of unexpected sounds. The whistling of the wind, and the melody of the grove, formed a concert, the soft cadence of which sunk upon my soul. I listened for some time, and was persuaded that all this music was within me.

Quite occupied with this new kind of existence, I had already forgotten the light which was my first inlet into life; when I once more opened my eyes, and found myself again in possession of my former happiness. The gratification of the two senses at once, was a pleasure too great for utterance.

I turned my eyes upon a thousand various objects: I soon found that I could lose them, and restore them at will; and amused myself more at leisure with a repetition of this new-made power.

I now began to gaze without emotion, and to hearken with tranquillity, when a light breeze, the freshness of which charmed me, wafted its perfumes to my sense of smelling; and gave me such satisfaction as even increased my self-love.

Agitated, roused by the various pleasures of my new existence, I instantly arose, and perceived myself moved along, as if by some unknown and secret power.

I had scarce proceeded forward; when the novelty of my situation once more rendered me immoveable. My surprize returned; I supposed that every object around me had been in motion: I gave to them that agitation which I produced by changing place; and the whole creation seemed once more in disorder.

I lifted my hand to my head; I touched my forehead; I felt my whole frame: I then supposed that my hand was the principal organ of my existence; all its informations were distinct and perfect; and so superior to the senses I had yet experienced, that I employed myself for some time in repeating its enjoyments: every part of my person I touched, seemed to touch my hand in turn; and gave back sensation for sensation.

I soon found, that this faculty was expanded over the whole surface of my body; and I now first began to perceive the limits of my existence, which I had in the beginning supposed spread over all the objects I saw.

Upon casting my eyes upon my body, and surveying my own form, I thought it greater than all the objects that surrounded me. I gazed upon my person with pleasure; I examined the formation of my hand, and all its motions; it seemed to me large or little in proportion as I approached it to my eyes; I brought it very near, and it then hid almost every other object from my sight. I began soon, however,



ever, to find that my sight gave me uncertain information, and resolved to depend upon my feeling for redress. I stretched forth my hand, and felt only yielding air: at every effort, I fell from one surprize into another, for every object appeared equally near me; and it was not till after an infinity of trials, that I found some objects further removed than the rest.

"I now, therefore, resolved to touch whatever I saw, and vainly attempted to touch the sun; I stretched forth my arm, and felt only yielding air: at every effort, I fell from one surprize into another, for every object appeared equally near me; and it was not till after an infinity of trials, that I found some objects further removed than the rest.

"Amazed with the illusions, and the uncertainty of my state, I sat down beneath a tree; the most beautiful fruits hung upon it, within my reach; I stretched forth my hand, and they instantly separated from the branch. I was proud of being able to grasp a substance without me; I held them up, and their weight appeared to me like an animated power that endeavoured to draw them to the earth. I found a pleasure in conquering their resistance.

"I held them near my eye; I considered their form and beauty; their fragrance still more allured me to bring them nearer; I approached them to my lips, and drank in their odours; the perfume invited my sense of tasting; and I soon tried a new sense—How new! how exquisite! Hitherto I had tasted only of pleasure; but now it was luxury. The power of tasting gave me the idea of possession.

"Flattered with this new acquisition, I continued its exercise; till an agreeable languor stealing upon my mind, I felt all my limbs become heavy, and all my desires suspended. My sensations were now no longer vivid and distinct; but seemed to lose every object, and presented only feeble images, confusedly marked. At that instant I sunk upon the flowery bank, and slumber seized me. All now seemed once more lost to me. It was then as if I was returning into my former nothing. How long my sleep continued, I cannot tell; as I yet had no perception of time. My awaking appeared like a second birth; I then perceived that I had ceased for a time to exist. This produced a new sensation of fear; and from this interruption in life, I began to conclude that I was not formed to exist for ever.

"In this state of doubt and perplexity, I began to harbour new suspicions; and to fear that sleep had robbed me of some of my late powers: when, turning on one side, to resolve my doubts, what was my amazement, to behold another being, like myself, stretched by my side! New ideas now began to arise; new passions, as yet unperceived, with fears, and pleasures, all took possession of my mind, and prompted my curiosity: love served to complete that happiness which was begun in the individual; and every sense was gratified in all its varieties."

## CHAP. X.

### Of old AGE and DEATH.

**E**VERY thing in nature has its improvement and decay. The human form is no sooner arrived at its state of perfection than it begins to decline. The alteration is, at first, insensible; and, often, several years are elapsed before we find our-

selves grown old. The news of this disagreeable change, too generally, comes from without, and we learn from others that we grow old, before we are willing to believe the report.

When the body has come to its full height, and is extended into its just dimensions; it then also begins to receive an additional bulk, which rather loads than assists it. This is formed from fat; which generally, at the age of thirty-five, or forty, covers all the muscles, and interrupts their activity. Every action is then performed with greater labour, and the increase of size only serves as a forerunner of decay.

The bones, also, become every day more solid. In the embryo they are as soft almost as the muscles and the flesh; but, by degrees, they harden, and acquire their natural vigour; but still, however, the circulation is carried on through them; and, how hard soever the bones may seem, yet the blood holds its current through them as through all other parts of the body. Of this we may be convinced, by an experiment, which was first accidentally discovered, by our ingenious countryman Mr. Belcher. Perceiving, at a friend's house, that the bones of hogs, which were fed upon madder, were red, he tried it upon various animals, by mixing this root with their usual food; and he found that it tintured the bones in all: an evident demonstration that the juices of the body had a circulation through the bones. He fed some animals alternately upon madder and their common food, for some time, and he found their bones tintured with alternate layers, in conformity to their manner of living. From all this, he naturally concluded, that the blood circulated through the bones as it does through every other part of the body; and that, how solid soever they seemed, yet, like the softest parts, they were furnished, through all their substance, with their proper canals. Nevertheless, these canals are of very different capacities, during the different stages of life. In infancy they are capacious; and the blood flows almost as freely through the bones as through any other part of the body; in manhood their size is greatly diminished; the vessels are almost imperceptible; and the circulation through them is proportionably slow. But, in the decline of life, the blood, which flows through the bones, no longer contributing to their growth, must necessarily serve to increase their hardness. The channels, that every where run through the human frame, may be compared to those pipes that we every where see crusted on the inside, by the water, for a long continuance, running through them. Both, every day grow less and less, by the small rigid particles which are deposited within them. Thus as the vessels are by degrees diminished, the juices, also, which were necessary for the circulation through them, are diminished in proportion; till, at length, in old age, those props of the human frame are not only more solid but more brittle.

The cartilages, or gristles, which may be considered as bones beginning to be formed, grow also more rigid. The juices circulating through them, for there is a circulation through all parts of the body, every day contributes to render them harder; so that these substances, which in youth are elastic and pliant, in age become hard and bony. As these cartilages are generally placed near the joints, the motion of the joints also must, of consequence, become more difficult. Thus, in old age, every action of the body is performed with labour; and the cartilages, formerly so supple, will now sooner break than bend.

As the cartilages acquire hardness, and unfit the joints for motion, so also that mucous liquor, which is always separated between the joints, and which serves, like oil to an hinge, to give them an easy and



and ready play, is now grown more scanty. It becomes thicker, and more clammy, more unfit for answering the purposes of motion; and from thence, in old age, every joint is not only stiff, but awkward. At every motion, this clammy liquor is heard to crack, and it is not without the greatest effort of the muscles that its resistance is overcome. The membranes that cover the bones, the joints, and the rest of the body, become, as we grow old, more dense and more dry. These which surround the bones, soon cease to be ductile. The fibres, of which the muscles or flesh is composed, become every day more rigid; and, while to the touch the body seems, as we advance in years, to grow softer, it is, in reality, increasing in hardness. It is the skin, and not the flesh, that we feel upon such occasions. The fat, and the flabbiness of that, seems to give an appearance of softness, which the flesh itself is very far from having. There are few can doubt this after trying the difference between the flesh of young and old animals. The first is soft and tender, the last is hard and dry.

The skin is the only part of the body that age does not contribute to harden. That stretches to every degree of tension; and we have horrid instances of its pliancy, in many disorders incident to humanity. In youth, therefore, while the body is vigorous and increasing, it still gives way to its growth. But, although it thus adapts itself to our increase, it does not in the same manner conform to our decay. The skin, which in youth was filled, and glossy, when the body begins to decline, has not elasticity enough to shrink entirely with its diminution. It hangs, therefore, in wrinkles, which no art can remove. The wrinkles of the body, in general, proceed from this cause. But those of the face seem to proceed from another; namely, from the many varieties of positions into which it is put by the speech, the food, or the passions. Every grimace, and every passion wrinkles up the visage into different forms. These are visible enough in young persons; but what at first was accidental, or transitory, becomes unalterably fixed in the visage as it grows older. From hence we may conclude, that a freedom from passions not only adds to the happiness of the mind, but preserves the beauty of the face; and the person that has not felt their influence, is less strongly marked by the decays of nature.

Hence, therefore, as we advance in age, the bones, the cartilages, the membranes, the flesh, the skin, and every fibre of the body, becomes more solid, more brittle, and more dry. Every part shrinks, every motion becomes more slow; the circulation of the fluids is performed with less freedom; perspiration diminishes; the secretions alter; the digestion becomes slow and laborious; and the juices, no longer serving to convey their accustomed nourishment, those parts may be said to live no longer when the circulation ceases. Thus the body dies by little and little: all its functions are diminished by degrees; life is driven from one part of the frame to another; universal rigidity prevails; and death at last seizes upon the little that is left.

As the bones, the cartilages, the muscles, and all other parts of the body are softer in women than in men, these parts must, of consequence, require a longer time to come to that hardness which hastens death. Women, therefore, ought to be a longer time in growing old than men; and this is actually the case. If we consult the tables which have been drawn up respecting human life, we shall find, that after a certain age they are more long-lived than men, all other circumstances the same. A woman of sixty has a better chance than a man of the same age to live till eighty. Upon the whole we may infer, that such persons as have been slow in coming up to maturity, will also be slow in growing old; and

this holds, as well with regard to other animals as to man.

The whole duration of the life of either vegetables, or animals, may be, in some measure, determined from their manner of coming to maturity. The tree, or the animal, which takes but a short time to increase to its utmost pitch, perishes much sooner than such as are less premature. In both, the increase upwards is first accomplished; and not till they have acquired their greatest degree of height do they begin to spread in bulk. Man grows up to stature till about the age of seventeen; but his body is not completely developed till about thirty. Dogs, on the other hand, are at their utmost size, in a year, and become as bulky as they usually are in another. However, man who is so long in growing, continues to live for four score, or an hundred years; but the dog seldom above twelve, or thirteen. In general, also, it may be said that large animals live longer than little ones, as they usually take a longer time to grow. But in all animals one thing is equally certain, that they carry the causes of their own decay about them; and that their deaths are necessary and inevitable. The prospects which some visionaries have formed of perpetuating life by remedies, have been often enough proved false by their own example. Such unaccountable schemes would, therefore, have died with them, had not the love of life always augmented our credulity.

When the body is naturally well formed, it is possible to lengthen out the period of life for some years by management. Temperance in diet is often found conducive to this end. The famous Cornaro, who lived to above an hundred years although his constitution was naturally feeble, as a strong instance of the benefit of an abstemious life. Moderation in the passions, also, many contribute to extend the term of our existence. Fontenelle, the celebrated writer, was naturally of a very weak and delicate habit of body. He was affected by the smallest irregularities; and had frequently suffered severe fits of illness from the slightest causes. But the remarkable equality of his temper, and his seeming want of passion, lengthened out his life to above an hundred. It was remarkable of him, that nothing could vex or make him uneasy; every occurrence seemed equally pleasing; and no event, however unfortunate, seemed to come unexpected. However, the term of life can be prolonged but for a very little time by any art we can use. We are told of men who have lived beyond the ordinary duration of human existence; such as Par, who lived to an hundred and forty-four; and Jenkins, to an hundred and sixty-five; yet these men used no peculiar arts to prolong life; on the contrary, it appears that these, as well as some others, remarkable for their longevity, were peasants, accustomed to the greatest fatigues, who had no settled rules of diet, but who often indulged in accidental excesses. Indeed, if we consider that the European, the Negro, the Chinese, and the American, the civilized man, and the savage, the rich and the poor, the inhabitants of the city, and of the country, though all so different in other respects, are yet entirely similar in the period allotted them for living; if we consider that neither the difference of race, of climate, of nourishment, of convenience, or of soil, makes any difference in the term of life; if we consider that those men who live upon raw flesh, or dried fishes, upon seago, or rice, upon cassava, or upon roots, nevertheless live as long as those who are fed upon bread and meat, we shall readily be brought to acknowledge, that the duration of life depends neither upon habit, custom, or the quantity of food, we shall confess, that nothing can change the laws of that mechanism which regulates the number of our years; and which can be chiefly affected only by long fasting, or great excess.



If there be any difference in the different periods of man's existence, it ought principally to be ascribed to the quality of the air. It has been observed, that in elevated situations there have been found more old people than in those that were low. The mountains of Scotland, Wales, Auvergne, and Switzerland, have furnished more instances of extreme old age than the plains of Holland, Flanders, Germany, or Poland. But, in general, the duration of life is nearly the same in most countries. Man, if not cut off by accidental diseases, is often found to live to ninety or an hundred years. Our ancestors did not live beyond that date; and, since the time of David, this term has undergone little alteration.

If we be asked how in the beginning men lived so much longer than at present, and by what means their lives were extended to nine hundred and thirty, or even nine hundred and sixty years, it may be answered, that the productions of the earth, upon which they fed, might be of a different nature at that time, from what they are at present. It may be answered, that the term was abridged by Divine command, in order to keep the earth from being over-stocked with human inhabitants; since, if every person were now to live and generate for nine hundred years, mankind would be increased to such a degree, that there would be no room for subsistence: so that the plan of Providence would be altered; which is seen not to produce life, without providing a proper supply.

But, to whatever extent life may be prolonged, or however some may have delayed the effects of age, death is the certain goal to which all are hastening. All the causes of decay which have been mentioned, contribute to bring on this dreaded dissolution. However, nature approaches to this awful period, by slow and imperceptible degrees; life is consuming day after day; and some one of our faculties, or vital principles, is every hour dying before the rest; so that death is only the last shade in the picture: and it is probable, that man suffers a greater change in going from youth to age, than from age into the grave. When we first begin to live, our lives may scarcely be said to be our own; as the child grows, life increases in the same proportion: and is at its height in the prime of manhood. But as soon as the body begins to decrease, life decreases also; for, as the human frame diminishes, and its juices circulate in smaller quantity, life diminishes and circulates with less vigour; so that as we begin to live by degrees, we begin to die in the same manner.

Why then should we fear death, if our lives have been such as not to make eternity dreadful! Why should we fear that moment which is prepared by a thousand other moments of the same kind! the first pangs of sickness being probably greater, than the last struggles of departure. Death, in most persons, is as calmly endured as the disorder that brings it on. If we enquire from those whose business it is to attend the sick and the dying, we shall find that, except in a very few acute cases, where the patient dies in agonies, the greatest number die quietly, and seemingly without pain; and even the agonies of the former, rather terrify the spectators, than torment the patient; for how many have we not seen who have been accidentally relieved from this extremity, and yet had no memory of what they then endured? In fact, they had ceased to live, during that time when they ceased to have sensation; and their pains were only those of which they had an idea.

The greatest number of mankind die, therefore, without sensation; and of those few that still preserve their faculties entire to the last moment, there is scarce one of them that does not also preserve the hopes of still out-living his disorder. Nature, for

the happiness of man, has rendered this sentiment stronger than his reason. A person dying of an incurable disorder, which he must know to be so, by frequent examples of his case; which he perceives to be so, by the inquietude of all around him, by the tears of his friends, and the departure of the face of the physician, is, nevertheless, still in hopes of getting over it. His interest is so great that he only attends to his own representations; the judgment of others is considered as an hasty conclusion; and while death every moment makes new inroads upon his constitution, and destroys life in some part, hope still seems to escape the universal ruin, and is the last that submits to the blow.

Cast your eyes upon a sick man, who has an hundred times told you that he felt himself dying, that he was convinced he could not recover, and that he was ready to expire; examine what passes on his visage, when, through zeal or indiscretion, any one comes to tell him that his end is at hand. You will see him change, like one who is told an unexpected piece of news. He now appears not to have thoroughly believed what he had been telling you himself; he doubted much; and his fears were greater than his hopes; but he still had some feeble expectations of living, and would not have seen the approaches of death, unless he had been alarmed by the mistaken assiduity of his attendants.

Death, therefore, is not that terrible thing which we suppose it to be. It is a spectre which frights us at a distance, but which disappears when we come to approach it more closely. Our ideas of its terrors are conceived in prejudice, and dressed up by fancy; we regard it not only as the greatest misfortune, but also as an evil accompanied with the most excruciating tortures: we have even increased our apprehensions, by reasoning on the extent of our sufferings. It must be dreadful, say some, since it is sufficient to separate the soul from the body; it must be long, since our sufferings are proportioned to the succession of our ideas; and these being painful, must succeed each other with extreme rapidity. In this manner has false philosophy laboured to augment the miseries of our nature; and to aggravate that period, which Nature has kindly covered with insensibility. Neither the mind, nor the body, can suffer these calamities; the mind is, at that time, mostly without ideas; and the body too much enfeebled to be capable of perceiving its pain. A very acute pain produces either death, or fainting, which is a state similar to death: the body can suffer but to a certain degree; if the torture becomes excessive, it destroys itself; and the mind ceases to perceive, when the body can no longer endure.

In this manner, excessive pain admits of no reflection; and wherever there are any signs of it, we may be sure that the sufferings of the patient are no greater than what we ourselves may have remembered to endure.

But, in the article of death, we have many instances in which the dying person has shewn that very reflection which pre-supposes an absence of the greatest pain; and, consequently, that pang which ends life, cannot even be so great as those which have preceded. Thus, when Charles XII. was shot at the siege of Frederickshall, he was seen to clap his hand on the hilt of his sword; and although the blow was great enough to terminate one of the boldest and bravest lives in the world, yet it was not painful enough to destroy reflection. He perceived himself attacked; he reflected that he ought to defend himself, and his body obeyed the impulse of his mind, even in the last extremity. Thus it is the prejudice of persons in health, and not the body in pain, that makes us suffer from the approach of death; we have, all our lives, contracted an habit of making out excessive pleasures and



and pains; and nothing but repeated experience shows us, how seldom the one can be suffered, or the other enjoyed to the utmost.

If there be any thing necessary to confirm what we have said, concerning the gradual cessation of life, or the insensible approaches of our end, nothing can more effectually prove it, than the uncertainty of the signs of death. If we consult what Winslow or Bruhier have said upon this subject, we shall be convinced, that between life and death, the shade is so very undistinguishable, that even all the powers of art can scarcely determine where the one ends, and the other begins. The colour of the visage, the warmth of the body, the suppleness of the joints, are but uncertain signs of life still subsisting; while on the contrary, the paleness of the complexion, the coldness of the body, the stiffness of the extremities, the cessation of all motion, and the total insensibility of the parts, are but uncertain marks of death begun. In the same manner also, with regard to the pulse, and the breathing, these motions are often so kept under, that it is impossible to perceive them. By approaching a looking-glass to the mouth of the person supposed to be dead, people often expect to find whether he breathes or not. But this is a very uncertain experiment: the glass is frequently sullied by the vapour of the dead man's body; and often the person is still alive, although the glass is no way tarnished. In the same manner, neither burning, nor scarifying, neither noises in the ears, nor pungent spirits applied to the nostrils, give certain signs of the discontinuance of life; and there are many instances of persons who have endured them all, and afterwards recovered, without any external assistance, to the astonishment of the spectators. How careful, therefore, should we be, before we commit those who are dearest to us to the grave, to be well assured of their departure? Experience, justice, humanity, all persuade us not to hasten the funerals of our friends, but to keep their bodies unburied, until we have certain signs of their real decease.

#### C. H. A. P. XI.

##### Of the Varieties in the HUMAN Race.

WE have hitherto considered man as an individual, endowed with excellencies above the rest of the creation; we now come to consider the advantages which men have over men, and the various kinds with which our earth is inhabited. If we compare the minute differences of mankind, there is scarce one nation upon the earth that entirely resembles another; and there may be said to be as many different kinds of men as there are countries inhabited. One polished nation does not differ more from another, than the merest savages do from those savages that lie even contiguous to them; and it frequently happens that a river, or a mountain, divides two barbarous tribes that are unlike each other in manners, customs, features, and complexion. But these differences, however perceivable, do not form such distinctions as come within a general picture of the varieties of mankind. Custom, accident, or fashion, may produce considerable alterations in neighbouring nations; their being derived from ancestors of a different climate, or complexion, may contribute to make accidental distinctions, which every day grow less; and it may be said, that two neighbouring nations, how unlike soever at first, will assimilate by degrees; and, by long continuance, the difference between them will at last become almost imperceptible. It is not, therefore, between contiguous nations we are to look for any strong marked varieties in the human species;

it is by comparing the inhabitants of opposite climates, and distant countries; those who live within the polar circle with those beneath the equator; those that live on one side of the globe with those that occupy the other.

Of all animals, the differences between mankind are the smallest. Of the lower race of creatures, the changes are so great as often entirely to disguise the natural animal, and to distort, or to disfigure its shape. But the chief differences in man are rather taken from the tincture of his skin, than the variety of his figure; and in all climates he preserves his erect deportment, and the marked superiority of his form. If we look round the world there seem to be not above six distinct varieties in the human species, each of which is strongly marked, and speaks the kind seldom to have mixed with any other. But there is nothing in the shape, nothing in the faculties, that shews their coming from different originals; and the varieties of climate, of nourishment, and custom, are sufficient to produce every change.

The first distinct race of men is found round the polar regions. The Laplanders, the Esquimaux Indians, the Samœid Tartars, the inhabitants of Nova Zembla, the Borandians, the Greenlanders, and the natives of Kamtscharka, may be considered as one peculiar race of people, all greatly resembling each other in their stature, their complexion, their customs, and their ignorance. These nations being under a rigorous climate, where the productions of nature are but few, and the provisions coarse and unwholesome, their bodies have shrunk to the nature of their food; and their complexions have suffered, from cold, almost a similar change to what heat is known to produce, their colour being a deep brown, in some places inclining to actual blackness. These, therefore, in general, are found to be a race of short stature, and odd shape, with countenances as savage as their manners are barbarous. The visage, in these countries, is large and broad, the nose flat and short, the eyes of a yellowish brown inclining to blackness, the eye-lids drawn towards the temples, the cheek-bones extremely high, the mouth very large, the lips thick and turned outwards, the voice thin and squeaking, the head large, the hair black and straight, the colour of the skin of a dark greyish. They are short in stature, the generality not being above four feet high, and the tallest not above five. Among all these nations the women are as deformed as the men, and resemble them so nearly that one cannot, at first, distinguish the sexes among them.

These nations not only resemble each other in their deformity, their dwarfishness, the colour of their hair and eyes, but they have, in a great measure, the same inclinations, and the same manners, being all equally rude, superstitious, and stupid. The Danish Laplanders have a large black cat, to which they communicate their secrets, and consult in all their affairs. Among the Swedish Laplanders there is in every family a drum for consulting the devil; and, although these nations are robust, and nimble, yet they are so cowardly, that they never can be brought into the field. Gustavus Adolphus attempted to form a regiment of Laplanders, but he found it impossible to accomplish his design; for it should seem that they can live only in their own country, and in their own manner. They make use of skates, which are made of fir, of near three feet long, and half a foot broad; these are pointed, and raised before, and tied to the foot by straps of leather. With these they skate upon the icy snow with such velocity, that they very easily overtake the swiftest animals. They make use also of a pole, pointed with iron at one end, and rounded at the other. The pole serves to push them along, so direct



# NATURAL HISTORY of MAN.

THE HOTTENTOT



THE AMERICAN



THE LAPLANDER



THE CHINESE



THE AFRICAN



A GREENLANDER









set their course, to support them from falling, to stop the impetuosity of their motion, and to kill that game which they have overtaken. Upon these skates they descend the steepest mountains, and scale the most craggy precipices; and, in these exercises, the women are not less skilful than the men. They have all the use of the bow and arrow, which seems to be a contrivance common to all barbarous nations; and which, however, at first, required no small skill to invent. They launch a javelin also, with great force; and some say that they can hit a mark, no larger than a crown, at thirty yards distance, and with such force as would pierce a man through. They are all hunters; and particularly pursue the ermine, the fox, the ounce, and the martin, for the sake of their skins. These they barter, with their southern neighbours, for brandy and tobacco; both which they are fond of to excess. Their food is principally dried fish, the flesh of rein-deer and bears. Their bread is composed of the bones of fishes, pounded and mixed with the inside bark of the pine-tree. Their drink is train-oil, or brandy, and, when deprived of these, water, in which juniper berries have been infused. With regard to their morals, they have all the virtues of simplicity, and all the vices of ignorance. They offer their wives and daughters to strangers; and seem to think it a particular honour if their offer be accepted. They have no idea of religion, or a Supreme Being; the greatest number of them are idolaters; and their superstition is as profound as their worship is contemptible. Wretched and ignorant as they are, yet they do not want pride; they set themselves far above the rest of mankind; and Krantz assures us, that when the Greenlanders are got together, nothing is so customary among them as to turn the Europeans into ridicule. They are obliged, indeed, to yield them the pre-eminence in understanding, and mechanic arts; but they do not know how to set any value upon these. They therefore count themselves the only civilized and well-bred people in the world; and it is common with them, when they see a quiet, or a modest stranger, to say that he is almost as well bred as a Greenlander.

From this description, therefore, this whole race of people may be considered as distinct from any other. Their long continuance in a climate the most inhospitable, their being obliged to subsist on food the most coarse and ill prepared, the savageness of their manners, and their laborious lives, all have contributed to shorten their stature, and to deform their bodies. In proportion as we approach towards the north pole, the size of the natives appears to diminish, growing less and less as we advance higher, till we come to those latitudes that are destitute of all inhabitants whatsoever.

The wretched natives of these climates seem fitted by nature to endure the rigours of their situation. As their food is but scanty and precarious, their patience in hunger is amazing. A man, who has ate nothing for four days, can manage his little canoe, in the most furious waves, and calmly subsist in the midst of a tempest, that would quickly dash an European boat to pieces. Their strength is not less amazing than their patience; a woman among them will carry a piece of timber, or a stone, near double the weight of what an European can lift. Their bodies are of a dark grey all over; and their faces brown, or olive. The tincture of their skins partly seems to arise from their dirty manner of living, being generally daubed with train-oil; and partly from the rigours of climate, as the sudden alterations of cold and raw air in winter, and of burning heats in summer, shade their complexions by degrees, till, in a succession of generations, they at last become almost black. As the countries in

which these reside are the most barren, so the natives seem the most barbarous of any part of the earth. Their more southern neighbours of America, treat them with the same scorn that a polished nation would treat a savage one; and we may readily judge of the rudeness of those manners, which even a native of Canada can think more barbarous than his own.

But the gradations of nature are imperceptible; and, while the north is peopled with such miserable inhabitants, there are here and there to be found, upon the edges of these regions, people of larger stature, and completer figure. A whole race of the dwarfish breed is often found to come down from the north, and settle more to the southward; and, on the contrary, it sometimes happens that southern nations are seen higher up, in the midst of these diminutive tribes, where they have continued for time immemorial. Thus the Ostiac Tartars seem to be a race that have travelled down from the north, and to be originally sprung from the minute savages we have been describing. There are also Norwegians, and Finlanders, of proper stature, who are seen to inhabit in latitudes higher even than Lapland. These, however, are but accidental migrations, and serve as shades to unite the distinct varieties of mankind.

The second great variety, in the human species, seems to be that of the Tartar race; from whence, probably, the little men we have been describing originally proceeded. The Tartar country, taken in general, comprehends the greatest part of Asia; and is, consequently, a general name given to a number of nations, of various forms and complexions. But, however they seem to differ from each other, they all agree in being very unlike the people of any other country. All these nations have the upper part of the visage very broad, and wrinkled even while yet in their youth. Their noses are short and flat, their eyes little and sunk in their heads; and, in some of them, they are seen five or six inches asunder. Their cheek-bones are high, the lower part of their visage narrow, the chin long and advanced forward, their teeth of an enormous size and growing separate from each other, their eye-brows thick, large, and covering their eyes, their eye-lids thick, the face broad and flat, the complexion olive coloured, and the hair black. They are of a middle size, extremely strong, and very robust. They have but little beard, which grows stragglingly on the chin. They have large thighs, and short legs. The ugliest of all are the Calmoucks, in whose appearance there seems to be something frightful. They all lead an erratic life, remaining under tents of hair, or skins. They live upon horse-flesh and that of camels, either raw or a little sodden between the horse and the saddle. They eat also fish dried in the sun. Their most usual drink is mares milk fermented with millet ground into meal. They all have the head shaven, except a lock of hair, on the top, which they let grow sufficiently long to form into tresses, on each side of the face. The women, who are as ugly as the men, wear their hair, which they bind up with bits of copper and other ornaments of a like nature. The majority of these nations have no religion, no settled notions of morality, no decency of behaviour. They are chiefly robbers; and the natives of Daggestan, who live near their more polished neighbours, make a traffic of Tartar slaves who have been stolen, and sell them to the Turks and the Persians. Their chief riches consist in horses, of which perhaps there are more in Tartary, than in any other part of the world. The natives are taught by custom to live in the same place with their horses; they are continually employed in managing them, and



and at last bring them to such great obedience, that the horse seems actually to understand the rider's intention.

To this race of men also, we must refer the Chinese and the Japanese, however different they seem in their manners and ceremonies. It is the form of the body we are now principally considering; and there is, between these countries, a surprising resemblance. It is in general allowed that the Chinese have broad faces, small eyes, flat noses, and scarce any beard; that they are broad and square-shouldered, and rather less in stature than Europeans. These are marks common to them and the Tartars, and they may, therefore, be considered as being derived from the same original. "I have observed," says Chardin, "that in all the people from the east and the north of the Caspian sea, to the peninsula of Malacca, that the lines of the face, and the formation of the visage, is the same. This has induced me to believe, that all these nations are derived from the same original, however different either their complexions or their manners may appear; for as to the complexion, that proceeds entirely from the climate and the food; and as to the manners, these are generally the result of their different degrees of wealth or power." That they come from one stock, is evident also, from this; that the Tartars who settle in China, quickly resemble the Chinese; and, on the contrary, the Chinese who settle in Tartary, soon assume the figure, and the manners of the Tartars.

The Japanese so much resemble the Chinese, that one cannot hesitate to rank them in the same class. They only differ in being rather browner, as they inhabit a more southern climate. They are, in general, described, as of a brown complexion, a short stature, a broad flat face, a very little beard, and black hair. Their customs and ceremonies are nearly the same; their ideas of beauty similar; and their artificial deformities of blackening the teeth, and bandaging the feet, entirely alike in both countries. They both, therefore, proceed from the same stock; and although they differ very much from their brutal progenitors, yet they owe their civilization wholly to the mildness of the climate in which they reside, and to the peculiar fertility of the soil. To this tribe also, we may refer the Cochinchinese, the Siamese, the Tonquinese, and the inhabitants of Aracan, Laos, and Pegu, who, though all differing from the Chinese, and each other, nevertheless, have too strong a resemblance, not to betray their common original.

Another, which makes the third variety in the human species, is that of the southern Asiatics; the form of whose features and persons may be easily distinguished from those of the Tartar races. The nations that inhabit the peninsula of India, seem to be the principal stock from whence the inhabitants of the islands that lie scattered in the Indian ocean, have been peopled. They are, in general, of a slender shape, with long straight black hair, and often with Roman noses. Thus they resemble the Europeans in stature and features; but greatly differ in colour and habit of body. The Indians are of an olive colour, and, in the more southern parts, quite black; although the word Mogul, in their language, signifies a white man. The women are extremely delicate, and bathe very often: they are of an olive colour, as well as the men; their legs and thighs are long, and their bodies short, which is the opposite to what is seen among the women of Europe. They are, it is said, by no means so fruitful as the European women; but they feel the pains of child-birth with much less sensibility, and are generally up and well the day following. In fact, these pains seem greatest in all countries where the women are most delicate, or the constitution enfee-

bled by luxury or indolence. The women of savage nations seem, in a great measure, exempt from painful labours; and even the hard-working wives of the peasants among ourselves, have this advantage from a life of industry, that their child-bearing is less painful. Over all India, the children arrive sooner at maturity, than with us of Europe. They often marry, and consummate, the husband at ten years old, and the wife at eight; and they frequently have children at that age. However, the women who are mothers so soon, cease bearing before they are arrived at thirty; and, at that time, they appear wrinkled, and seem marked with all the deformities of age. The Indians have long been remarkable for their cowardice and effeminacy; every conqueror that has attempted the invasion of their country, having succeeded. The warmth of the climate entirely influences their manners; they are slothful, submissive and luxurious: satisfied with sensual happiness alone, they find no pleasure in thinking; and contented with slavery, they are ready to obey any master. Many tribes among them eat nothing that has life; they are fearful of killing the meanest insect; and have even erected hospitals for the maintenance of all kinds of vermin. The Asiatic dress is a loose flowing garment, rather fitted for the purposes of peace and indolence, than of industry or war. The vigour of the Asiatics is in general conformable to their dress and nourishment; fed upon rice, and clothed in effeminate silk vestments, their soldiers are unable to oppose the onset of an European army; and, from the times of Alexander to the present day, we have scarce any instances of their success in arms. Upon the whole, therefore, they may be considered as a feeble race of sensualists, too dull to find rapture in any pleasures, and too indolent to turn their gravity into wisdom. To this class we may refer the Persians and Arabians, and, in general, the inhabitants of the islands that lie scattered in the Indian ocean.

The fourth striking variety in the human species, is to be found among the Negroes of Africa. This gloomy race of mankind is found to blacken all the southern parts of Africa, from eighteen degrees north of the line, to its extreme termination, at the Cape of Good Hope. It is said, that the Caffres, who inhabit the southern extremity of that large continent, are not to be ranked among the Negro race; however, the difference between them, in point of colour and features, is so small, that they may very easily be grouped in this general picture. Each of the Negro nations, it must be owned, differs from each other; they have their peculiar countries for beauty, like us; and different nations, as in Europe, pride themselves upon the regularity of their features. Those of Guinea, for instance, are extremely ugly, and have an insupportable scent; those of Mosambique are reckoned beautiful, and have no ill smell whatsoever. The Negroes, in general, are of a black colour, with a smooth soft skin. This smoothness proceeds from the downy softness of the hair which grows upon it; the strength of which gives a roughness to the feel, in those of a white complexion. Their skins, therefore, have a velvet smoothness, and seem less braced upon the muscles than ours. The hair of their heads differs entirely from what we are accustomed to, being soft, woolly, and short. The beard also, partakes of the same qualities; but in this it differs, that it soon turns grey, which the hair is seldom found to do; so that several are seen with white beards, and black hair, at the same time. Their eyes are generally of a deep hazel, their noses flat and short, their lips thick and tumid, and their teeth of an ivory whiteness. This their only beauty, however, is set off by the colour of their skin; the contrast between the black



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# NATURAL HISTORY of MAN.



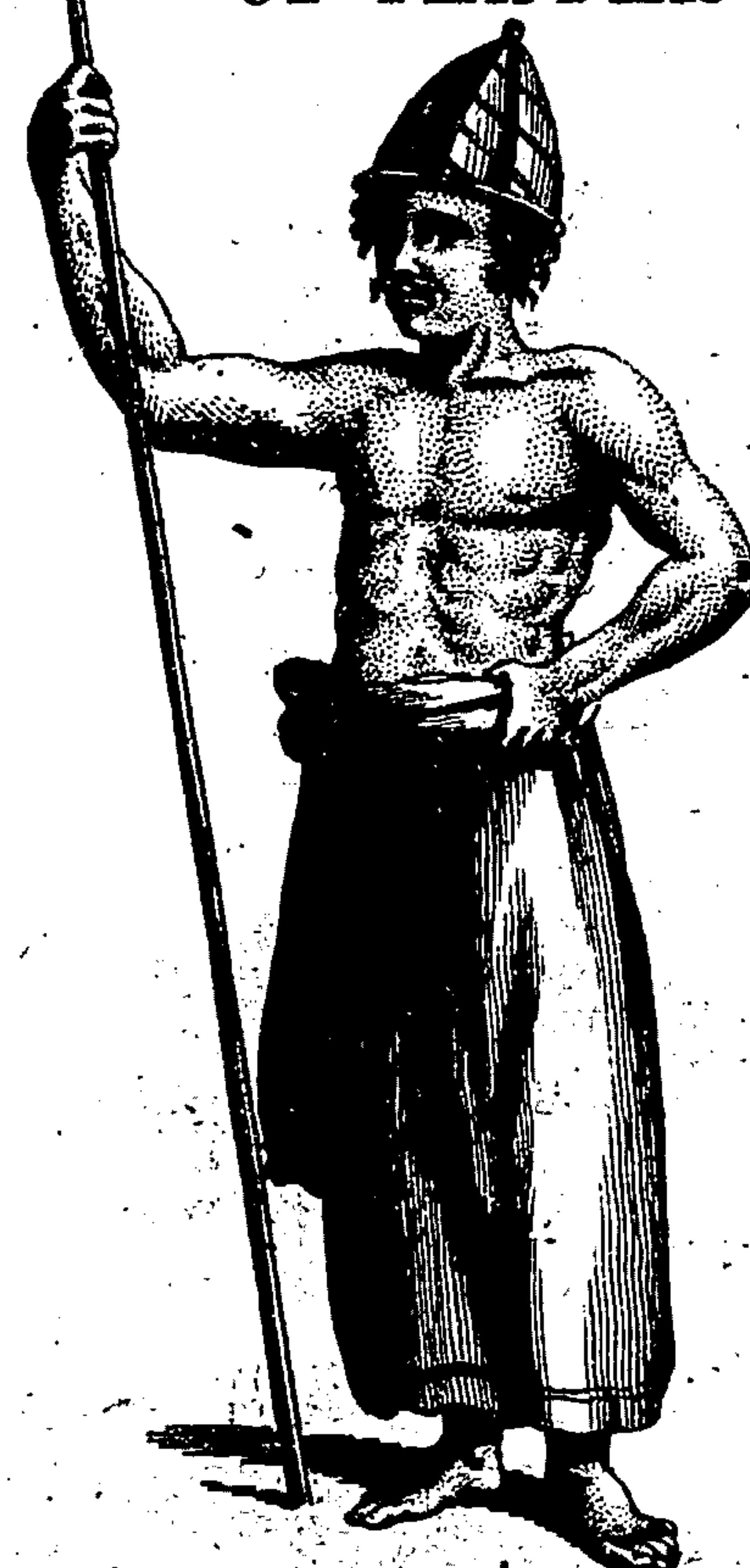
*A MALABAR*



*A TARTAR*



*An ALGERINE*



*A JAVANESE*



*A HIGHLANDER*



*An HUNGARIAN*



black and white being the more observable. It is false to say that their features are deformed by art; since, in the Negroe children born in European countries, the same deformities are seen to prevail; the same flatness in the nose; and the same prominence in the lips. They are, in general, said to be well shaped; but there is seldom found one that might be justly called so; their legs being mostly ill formed, and commonly bending outward on the shin-bone. But it is not only in those parts of their bodies that are obvious, that they are disproportioned; those parts which among us are usually concealed by dress, with them are large and languid. The women's breasts, after bearing one child, hang down below the navel; and it is customary, with them, to suckle the child at their backs, by throwing the breast over the shoulder. As their persons are thus naturally deformed, at least to our imaginations, their minds are equally incapable of strong exertions. The climate seems to relax their mental powers still more than those of the body; they are, therefore, in general, found to be stupid, indolent, and mischievous. The Arabians themselves, many colonies of whom have migrated southward into the most inland parts of Africa, seem to have degenerated from their ancestors; forgetting their ancient learning, and losing their beauty, they have become a race scarce any way distinguishable from the original natives. Nor does it seem to have fared otherwise with the Portuguese, who, about two centuries ago, settled along this coast. They also are become almost as black as the Negroes; and are said, by some, to be even more barbarous.

The inhabitants of America make a fifth race, as different from all the rest in colour, as they are distinct in habitation. The natives of America (except in the northern extremity, where they resemble the Laplanders) are of a red or copper colour; and although, in the old world, different climates produce a variety of complexions and customs, the natives of the new continent seem to resemble each other in almost every respect. They are all nearly of one colour; all have black thick straight hair, and thin black beards; which, however, they take care to pluck out by the roots. They have, in general, flat noses, with high cheek bones, and small eyes; and these deformities of nature they endeavour to increase by art; they flatten the nose, and often the whole head of their children, while the bones are yet susceptible of every impression. They paint the body and face of various colours, and consider the hair upon any part of it, except the head, as a deformity which they are careful to eradicate. Their limbs are generally lighter made than those of the Europeans; and they are far from being so strong. All these savages seem to be cowardly; they seldom are known to face their enemies in the field; but fall upon them at an advantage; and the greatness of their fears serves to increase the rigours of their cruelty. The wants which they often sustain, makes them surprisingly patient in adversity; distress, by being grown familiar, becomes less terrible; so that their patience is less the result of fortitude than of custom. They have all a serious air, although they seldom think; and, however cruel to their enemies, are kind and just to each other. In short, the customs of savage nations in every country are almost the same; a wild, independent, and precarious life, produces a peculiar train of virtues and vices; and patience and hospitality, indolence and rapacity, content and sincerity, are found not less among the natives of America, than all the barbarous nations of the globe.

The sixth and last variety of the human species, is that of the Europeans, and the nations bordering on them. In this class we may reckon the Georgians, Circassians, and Mingrelians, the inha-

bitants of Asia Minor, and the northern parts of Africa, together with a part of those countries which lie north-west of the Caspian sea. The inhabitants of these countries differ a good deal from each other; but they generally agree in the colour of their bodies, the beauty of their complexions, the largeness of their limbs, and the vigour of their understandings. Those arts which might have had their invention among the other races of mankind, have come to perfection there. In barbarous countries, the inhabitants go either naked, or are awkwardly clothed in furs or feathers; in countries semi-barbarous, the robes are loose and flowing; but here the cloathing is less made for shew than expedition; and unites, as much as possible, the extremes of ornament and dispatch.

To one or other of these classes, we may refer the people of every country; and as each nation has been less visited by strangers, or has had less commerce with the rest of mankind, we find their persons, and their manners, more strongly impressed with one or other of the characters mentioned above. On the contrary, in those places where trade has long flourished, or where enemies have made many incursions, the races are usually found blended, and properly fall beneath no one character. Thus, in the islands of the Indian ocean, where a trade has been carried on for time immemorial, the inhabitants appear to be a mixture of all the nations upon the earth; white, olive, brown, and black men, are all seen living together in the same city, and propagate a mixed breed, that can be referred to none of the classes into which naturalists have thought proper to divide mankind.

Of all the colours by which mankind is diversified, it is easy to perceive, that ours is not only the most beautiful to the eye, but the most advantageous. The fair complexion seems, if we may so express it, as a transparent covering to the soul; all the variations of the passions, every expression of joy or sorrow, flows to the cheek, and, without language, marks the mind. In the slightest change of health also, the colour of the European face is the most exact index, and often teaches us to prevent those disorders that we do not as yet perceive; not but that the African black, and the Asiatic olive complexions, admit of their alterations also; but these are neither so distinct, nor so visible, as with us; and, in some countries, the colour of the visage is never found to change; but the face continues in the same settled shade, in shame, and in sickness, in anger, and despair.

The colour, therefore, most natural to man, ought to be that which is most becoming; and it is found, that, in all regions, the children are born fair, or at least red; and that they grow more black or tawny, as they advance in age. It should seem, consequently, that man is naturally white; since the same causes that darken the complexion in infants, may have originally operated, in slower degrees, in blackening whole nations. We could, therefore, readily account for the blackness of different nations, did we not see the Americans, who live under the line, as well as the natives of Negroland, of a red colour, and but a very small shade darker than the natives of the northern latitudes, in the same continent. For this reason, some have sought for other causes of blackness than the climate; and have endeavoured to prove that the blacks are a race of people, bred from one man, who was marked with accidental blackness. This, however, is but mere ungrounded conjecture; and, although the Americans are not so dark as the Negroes, yet we must still continue in the ancient opinion, that the deepness of the colour proceeds from the excessive heat of the climate; for, if we compare the heat of Africa with those of America, we must find they bear no proportion



proportion to each other. In America, all that part of the continent which lies under the line, is cool and pleasant, either shaded by mountains, or refreshed by breezes from the sea; but, in Africa, the wide tract of country that lies under the line is very extensive, and the soil sandy; the reflection of the sun, therefore, from so large a surface of the earth, is almost intolerable; and it is not to be wondered at, that the inhabitants should bear, in their looks, the marks of the inhospitable climate. In America, the country is but thinly inhabited; and the more torrid tracts are generally left desert by the inhabitants; for which reason they are not so deeply tinged by the beams of the sun. But in Africa the whole face of the country is fully peopled; and the natives are obliged to endure their situation, without a power of migration. It is there, consequently, that they are in a manner tied down to feel all the severity of the heat; and their complexions take the darkest hue they are capable of receiving. We need not, therefore, have recourse to any imaginary propagation, from persons accidentally black, since the climate is a cause obvious, and sufficient to produce the effect.

In fact, if we examine the complexion of different countries, we shall find them darken in proportion to the heat of their climate; and the shades gradually to deepen as they approach the line. Some nations, indeed, may be found not so much tinged by the sun as others, although they lie nearer the line. But this ever proceeds from some accidental causes; either from the country lying higher, and consequently being colder; or from the natives bathing oftener, and leading a more civilized life. In general, it may be asserted, that as we approach the line, we find the inhabitants of each country grow browner until the colour deepens into perfect blackness. Thus taking our standard from the whitest race of people, and beginning with our own country, which certainly bids fairest for the pre-eminence, we shall find the French, who are more southern, a slight shade deeper than we; going farther down, the Spaniards are browner than the French; the inhabitants of Fez darker than they; and the natives of Negroeland the darkest of all. In what manner the sun produces this effect, and how the same luminary which whitens wax and linen, should darken the human complexion, is not easy to conceive. Sir Thomas Brown first supposed that a mucous substance, which had something of a vitriolic quality, settled under the reticular membrane, and grew darker with heat. Others have supposed that the blackness lay in the epidermis, or scarf skin, which was burnt up like leather. But nothing has been satisfactorily discovered upon the subject; it is sufficient that we are assured of the fact; and that we have no doubt of the sun's tinging the complexion in proportion to its vicinity.

But we are not to suppose that the sun is the only cause of darkening the skin; the wind, extreme cold, hard labour, or coarse and sparing nourishment, are all found to contribute to this effect. We find the peasants of every country, who are most exposed to the weather, a shade darker than the higher ranks of people. The savage inhabitants of all places are exposed still more, and, therefore, contract a still deeper hue; and this will account for the tawny colour of the North American Indians. Although they live in a climate the same, or even more northerly than ours, yet they are found to be of complexions very different from those of Europe. But it must be considered that they live continually exposed to the sun; that they use many methods to darken their skins by art, painting them with red ochre, and anointing them with the fat of bears. Had they taken, for a succession of several generations, the same precautions to brighten their co-

lour that an European does, it is very probable that they would in time come to have similar complexions; and, perhaps, dispute the prize of beauty.

The extremity of cold is not less productive of a tawny complexion than that of heat. The natives of the arctic circle, as was observed, are all brown; and those that lie most to the north are almost entirely black. In this manner both extremes are unfavourable to the human form and colour, and the same effects are produced under the poles that are found at the line.

With regard to the stature of different countries, that seems chiefly to result from the nature of the food, and the quantity of the supply. Not but that the severity of heat or cold, may, in some measure, diminish the growth, and produce a dwarfishness of make. But, in general, the food is the great agent in producing this effect; where that is supplied in large quantities, and, where its quality is wholesome and nutrimental, the inhabitants are generally seen above the ordinary stature. On the contrary, where it is afforded in a sparing quantity, or very coarse, and void of nourishment in its kind, the inhabitants degenerate, and sink below the ordinary size of mankind. In this respect they resemble other animals, whose bodies, by proper feeding, may be greatly augmented. An ox, on the fertile plains of India, grows to a size four times as large as the diminutive animal of the same kind bred in the Alps. The horses bred in the plains are larger than those of the mountain. So it is with man; the inhabitants of the valley are usually found taller than those of the hill: the natives of the Highlands of Scotland, for instance, are short, broad, and hardy; those of the Lowlands are tall and shapely. The inhabitants of Greenland, who live upon dried fish and seals, are less than those of Gambia or Senegal, where Nature supplies them with vegetable and animal abundance.

The form of the face seems rather to be the result of custom. Nations who have long considered some artificial deformity as beautiful, who have industriously lessened the feet, or flattened the nose, by degrees, begin to receive the impression they are taught to assume; and Nature, in a course of ages, shapes itself to the constraint, and assumes hereditary deformity. We find nothing more common in births than for children to inherit sometimes even the accidental deformities of their parents. We have many instances of squinting in the father, which he received from fright, or habit; communicated to the offspring; and we have seen a child distinctly marked with a scar, similar to one the father had received in battle. In this manner accidental deformities may become natural ones; and by assiduity may be continued, and even increased, through successive generations. From this, therefore, may have arisen the small eyes and long ears of the Tartars, and Chinese nations. From hence originally may have come the flat noses of the blacks, and the flat heads of the American Indians.

In this slight survey, therefore, we may see that all the variations in the human figure, as far as they differ from our own, are produced either by the rigour of the climate, the bad quality, or the scantiness of the provisions, or by the savage customs of the country. They are actual marks of the degeneracy in the human form; and we may consider the European figure and colour as standards to which to refer all other varieties, and with which to compare them. In proportion as the Tartar or American approaches nearer to European beauty, we consider the race as less degenerated; in proportion as he differs more widely, he has made greater deviation from his original form.

That we have all sprung from one common parent, we are taught, both by reason and religion, to believe;



lieve, and we have good reason also to think that the Europeans resemble him more than any of the rest of his children. However, it must not be concealed that the olive coloured Asiatic, and even the jet black Negroe, claim this honour of hereditary resemblance; and assert that white men are mere deviations from original perfection. Odd as this opinion may seem, they have Linnæus, the celebrated naturalist, on their side, who supposes man a native of the tropical climates, and only a sojourner more to the north. But, not to enter into a controversy upon a matter of a very remote speculation, one argument alone will suffice to prove the contrary, and shew that the white man is the original source from whence the other varieties have sprung. We have frequently seen white children produced from black parents, but have never seen a black offspring the production of two whites. From hence we may conclude that whiteness is the colour to which mankind naturally tends; for, as in the tulip, the parent stock is known by all the artificial varieties breaking into it; so in man, that colour must be original which never alters, and to which all the rest are accidentally seen to change. We have seen in London, at different times, two white Negroes, the issue of black parents, that served to convince us of the truth of this theory. We had before been taught to believe that the whiteness of the Negroe skin was a disease, a kind of milky whiteness, that might be called rather a leprous crust than a natural complexion. We were taught to suppose that the numberless white Negroes, found in various parts of Africa; the white men that go by the name of Chacrelas, in the East Indies, and the white Americans, near the Isthmus of Darien, in the West Indies, were all as so many diseased persons, and even more deformed than the blackest of the natives. But, upon examining that Negroe which was last shewn in London, the colour was found to be exactly like that of an European; the visage white and ruddy; and the lips of the proper redness. However, there were sufficient marks to convince us of its descent. The hair was white and woolly, and very unlike anything ever seen before. The iris of the eye was yellow, inclining to red; the nose was flat, exactly resembling that of a Negro; and the lips thick, and prominent. No doubt, therefore, remained of the child's having been born of Negroe parents; and the person who shewed it had attestations to convince the most incredulous. From this then we see that the variations of the Negroe colour is into whiteness, whereas the white are never found to have a race of Negroe children. Upon the whole, all those changes which the African, the Asiatic or the American undergo, are but accidental deformities, which a kinder climate, better nourishment, or more civilized manners, would, in a course of centuries, very probably remove.

C. H. A. P. XII.

OF MONSTERS.

**H**ITHERTO we have only spoken of those varieties in the human species, that are common to whole nations; but there are varieties of another kind, which are only found in the individual; and, being more rarely seen, are, therefore, called monstrous. If we examine into the varieties of distorted nature, there is scarce a limb of the body, or a feature in the face, that has not suffered some reprobation, either from art or nature, being enlarged or diminished, lengthened or wrested from its due proportion. Linnæus, after having given

a catalogue of monsters, particularly adds, the flat heads of Canada, the long heads of the Chinese, and the slender waists of the women of Europe, who, by strait lacing, take such pains to destroy their health, through a mistaken desire to improve their beauty. It belongs more to the physician than the naturalist to attend to these minute deformities; and, indeed, it is a melancholy contemplation to speculate upon a catalogue of calamities, inflicted by un pitying nature, or brought upon us by our own caprice. Some, however, are fond of such accounts; and there have been books filled with nothing else. It is sufficient here to observe, that every day's experience must have shewn us miserable instances of this kind, produced by nature, or affectation; calamities that no pity can soften, nor assiduity relieve.

Passing over, therefore, every other account, we shall only mention the famous instance, quoted by Father Malbranche, upon which he founds his beautiful theory of monstrous productions. A woman of Paris, the wife of a tradesman, went to see a criminal broke alive upon the wheel, at the place of public execution. She was at that time two months advanced in her pregnancy, and no way subject to any disorders to affect the child in her womb. She was, however, of a tender habit of body; and, though led by curiosity to this horrid spectacle, very easily moved to pity and compassion. She felt, therefore, all those strong emotions which so terrible a sight must naturally inspire; shuddered at every blow the criminal received, and almost swooned at his cries. Upon returning from this scene of blood, she continued for some days pensive, and her imagination still wrought upon the spectacle she had lately seen. After some time, however, she seemed perfectly recovered from her fright, and had almost forgotten her former uneasiness. When the time of her delivery approached, she seemed no ways mindful of her former terrors, nor were her pains in labour more than usual in such circumstances. But, what was the amazement of her friends, and assistants, when the child came into the world! It was found that every limb in its body was broken like those of the malefactor, and just in the same place. This poor infant that had suffered the pains of life, even before its coming into the world, did not die, but lived in an hospital, in Paris, for twenty years after, a wretched instance of the supposed powers of imagination in the mother, of altering and distorting the infant in the womb. The manner in which Malbranche reasons upon this fact, is as follows: The Creator has established such a sympathy between the several parts of nature, that we are led not only to imitate each other, but also to partake in the same affections and desires. The animal spirits are thus carried to the respective parts of the body, to perform the same actions which we see others perform, to receive in some measure their wounds, and take part in their sufferings. Experience tells us, that if we look attentively on any person severely beaten, or sorely wounded, the spirits immediately flow into those parts of the body which correspond to those we see in pain. The more delicate the constitution, the more it is thus affected; the spirits making a stronger impression on the fibres of a weakly habit than of a robust one. Strong vigorous men see an execution without much concern, while women of nicer texture are struck with horror and concern. This sensibility in them must, of consequence, be communicated to all parts of their body; and, as the fibres of the child, in the womb, are incomparably finer than those of the mother, the course of the animal spirits must, consequently, produce greater alterations. Hence, every stroke given to the criminal, forcibly struck the imagination of the woman;



woman; and by a kind of counter stroke, the delicate tender frame of the child.

Such is the reasoning of an ingenious man, upon a fact the veracity of which many since have called in question. They have allowed, indeed, that such a child might have been produced, but have denied the cause of its deformity. How could the imagination of the mother, say they, produce such dreadful effects upon her child? She has no communication with the infant; she scarce touches it in any part; quite unaffected with her concerns, it sleeps in security, in a manner secluded by a fluid in which it swims, from her that bears it. With what a variety of deformities, say they, would all mankind be marked, if all the vain and capricious desires of the mother were thus readily written upon the body of child? Yet, notwithstanding this plausible way of reasoning, we cannot avoid giving some credit to the variety of instances we have either read, or seen, upon this subject. If it be a prejudice, it is as old as the days of Aristotle, and to this day as strongly believed, by the generality of mankind, as ever. It does not admit of a reason; and, indeed, we can give none even why the child should, in any respect, resemble the father, or the mother. The fact we generally find to be so. But why it should take the particular print of the father's features in the womb, is as hard to conceive, as why it should be affected by the mother's imagination. We all know what a strong effect the imagination has on those parts in particular, without being able to assign a cause how this effect is produced; and why may not the imagination produce the same effect in marking the child that it does in forming it? Those persons whose employment it is to rear up pigeons of different colours, can breed them, as their expression is, to a feather. In fact, by properly paring them, they can give what colour they will to any feather, in any part of the body. Were we to reason upon this fact, what could we say? Might it not be asserted, that the egg, being distinct from the body of the female, cannot be influenced by it? Might it not be plausibly said, that there is no similitude between any part of the egg and any particular feather, which we expect to propagate? and yet, for all this, the fact is known to be true, and what no speculation can invalidate. In the same manner, a thousand various instances assure us that the child, in the womb, is sometimes marked by the strong affections of the mother; how this is performed we know not; we only see the effect, without any connexion between it and the cause. The best physicians have allowed it; and have been satisfied to submit to the experience of a number of ages; but many disbelieve it, because they expect a reason for every effect. This, however, is very hard to be given, while it is very easy to appear wise by pretending incredulity.

Among the number of monsters, dwarfs and giants are usually reckoned; though not, perhaps, with the strictest propriety, since they are no way different from the rest of mankind, except in stature. It is a dispute, however, about words; and, therefore, scarce worth contending about. But there is a dispute of a more curious nature, on this subject; namely, whether there are races of people thus very diminutive, or vastly large, or whether they be merely accidental varieties, that now and then are seen in the country, in a few persons, whose bodies some external cause has contributed to lessen or enlarge.

With regard to men of diminutive stature, all antiquity has been unanimous in asserting their national existence. Homer was the first who has given us an account of the pigmy nation, contending with the cranes; and what poetical licence might be supposed to exaggerate, Athenæus has attempted se-

riously to confirm by historical assertion. If we attend to these, we must believe that in the internal parts of Africa, there are whole nations of pigmy beings, not more than a foot in stature, who continually wage an unequal war with the birds and beasts that inhabit the plains in which they reside. Some of the ancients, however, and Strabo in particular, have supposed all these accounts to be fabulous; and have been more inclined to think this supposed nation of pigmies, nothing more than a species of apes, well known to be numerous in that part of the world. With this opinion the moderns have all concurred; and that diminutive race, which was described as human, has been long degraded into a class of animals that resemble us but very imperfectly.

The existence, therefore, of a pigmy race of mankind, being founded in error, or in fable, we can expect to find men of diminutive stature only by accident, among men of the ordinary size. Of these accidental dwarfs, every country, and almost every village, can produce numerous instances. There was a time, when these unfavoured children of Nature were the peculiar favourites of the great; and no prince, or nobleman, thought himself completely attended, unless he had a dwarf among the number of his domestics. These poor little men were kept to be laughed at; or to raise the barbarous pleasure of their masters, by their contrasted inferiority. Even in England, as late as the times of king James the First, the court was at one time furnished with a dwarf, a giant, and a jester: these the king often took a pleasure in opposing to each other, and often fomented quarrels among them, in order to be a concealed spectator of their animosity. It was a particular entertainment of the courtiers at that time, to see little Jeffery, for so the dwarf was called, ride round the lifts, expecting his antagonist; and discovering, in his actions, all the marks of contemptible resolution.

It was in the same spirit, that Peter of Russia, in the year 1710, celebrated a marriage of dwarfs. This monarch, though raised by his native genius far above a barbarian, was, nevertheless, still many degrees removed from actual refinement. His pleasures, therefore, were of the vulgar kind; and this was among the number. Upon a certain day, which he had ordered to be proclaimed several months before, he invited the whole body of his courtiers, and all the foreign ambassadors, to be present at the marriage of a pigmy man and woman. The preparations for this wedding were not only very grand, but executed in a style of barbarous ridicule. He ordered, that all the dwarf men and women, within two hundred miles, should repair to the capital; and also insisted, that they should be present at the ceremony. For this purpose, he supplied them with proper vehicles; but so contrived it, that one horse was seen carrying in a dozen of them into the city at once, while the mob followed shouting, and laughing, from behind. Some of them were at first unwilling to obey an order, which they knew was calculated to turn them into ridicule, and did not come; but he soon obliged them to obey; and, as a punishment, enjoined, that they should wait upon the rest at dinner. The whole company of dwarfs amounted to seventy, beside the bride and bridegroom, who were richly adorned, and in the extremity of the fashion. For this little company in miniature, every thing was suitably provided; a low table, small plates, little glasses, and, in short, every thing was so fitted, as if all things had been dwindled to their own standard. It was his great pleasure to see their gravity and their pride; the contention of the women for places, and the men for superiority. This point he attempted to adjust, by ordering, that the most diminutive



native should take the lead; but this bred disputes, for none would then consent to sit foremost. All this, however, being at last settled, dancing followed the dinner, and the ball was opened with a minuet by the bridegroom, who measured exactly three feet two inches high. In the end, matters were so contrived, that this little company, who met together in gloomy pride, and unwilling to be pleased, being at last familiarized to laughter, joined in the diversion, and became, as the journalist has it, extremely sprightly and entertaining.

But whatever may be the entertainment such guests might afford, when united, a dwarf is seldom found capable of affording any when alone. They, in general, seem to have faculties very much resembling those of children, and their desires of the same kind; being diverted with the same sports, and best pleased with such companions. The little man, whose name was Coan, that died lately at Chelsea, was the most intelligent and sprightly we ever heard of. But this mirth, and seeming sagacity, were but assumed. He had, by long habit, been taught to look cheerful upon the approach of company; and his conversation was but the mere etiquette of a person that had been used to receive visitors. When driven out of his walk, nothing could be more stupid or ignorant, nothing more dejected or forlorn. But, we have a compleat history of a dwarf, very accurately related by Mr. Daubenton, in his part of the *Histoire Naturelle*; which we will here take leave to translate.

This dwarf, whose name was Baby, was well known, having spent the greatest part of his life at Lunenville, in the palace of Stanislaus, the titular king of Poland. He was born in the village of Plaine, in France, in the year 1741. His father and mother were peasants, both of good constitutions, and inured to a life of husbandry and labour. Baby, when born, weighed but a pound and a quarter. We are not informed of the dimensions of his body at that time; but we may conjecture they were very small, as he was presented on a plate to be baptized, and for a long time lay in a slipper. His mouth, although proportioned to the rest of his body, was not, at that time, large enough to take in the nipple; and he was, therefore, obliged to be suckled by a she-goat that was in the house; and that served as a nurse, attending to his cries with a kind of maternal fondness. He began to articulate some words when eighteen months old; and at two years he was able to walk alone. He was then fitted with shoes that were about an inch and a half long. He was attacked with several acute disorders; but the small-pox was the only one which left any marks behind it. Until he was six years old, he eat no other food but pulse, potatoes, and bacon. His father and mother were, from their poverty, incapable of affording him any better nourishment; and his education was little better than his food, being bred up among the rustics of the place. At six years old he was about fifteen inches high; and his whole body weighed but thirteen pounds. Notwithstanding this, he was well proportioned, and handsome; his health was good, but his understanding scarce passed the bounds of instinct. It was at that time that the king of Poland, having heard of such a curiosity, had him conveyed to Lunenville, gave him the name of Baby, and kept him in his palace.

Baby, having thus quitted the hard condition of a peasant, to enjoy all the comforts and the conveniences of life, seemed to receive no alteration from his new way of living, either in mind or person. He preserved the goodness of his constitution till about the age of sixteen, but his body seemed to increase very slowly during the whole time; and his stupidity was such, that all instructions were lost in improving his understanding. He could never be

brought to have any sense of religion, nor even to shew the least signs of a reasoning faculty. They attempted to teach him dancing and music, but in vain; he never could make any thing of music; and as for dancing, although he beat time tolerably exact, yet he could never remember the figure, but while his dancing-master stood by to direct his motions. Notwithstanding, a mind thus destitute of understanding was not without its passions; anger and jealousy harried it at times; nor was he without desires of another nature.

At the age of sixteen, Baby was twenty-nine inches tall; at this he rested; but having thus arrived at his acme, the alterations of puberty, or rather, perhaps, of old age, came fast upon him. From being very beautiful, the poor little creature now became quite deformed; his strength quite forsook him; his back bone began to bend; his head hung forward; his legs grew weak; one of his shoulders turned awry; and his nose grew disproportionably large. With his strength, his natural spirits also forsook him; and, by the time he was twenty, he was grown feeble, decrepid, and marked with the strongest impression of old age. It had been before remarked by some, that he would die of old age before he arrived at thirty; and, in fact, by the time he was twenty-two, he could scarcely walk an hundred paces, being worn with the multiplicity of his years, and bent under the burthen of protracted life. In this year he died; a cold, attended with a slight fever, threw him into a kind of lethargy, which had a few momentary intervals; but he could scarce be brought to speak. However, it is asserted, that in the five last days of his life, he shewed a clearer understanding, than in his times of best health; but at length he died, after enduring great agonies, in the twenty-second year of his age.

Opposite to this accidental diminution of the human race, is that of its extraordinary magnitude. Concerning the reality of a nation of Giants, there have been many disputes among the learned. Some have affirmed the probability of such a race; and others, as warmly have denied the possibility of their existence. But it is not from any speculative reasonings, upon a subject of this kind, that information is to be obtained; it is not from the disputes of the scholar, but the labours of the enterprising, that we are to be instructed in this enquiry. Indeed, nothing can be more absurd, than what some learned men have advanced upon this subject. It is very unlikely, says Grew, that there should either be dwarfs or giants; or if such, they cannot be fitted for the usual enjoyment of life and reason. Had man been born a dwarf, he could not have been a reasonable creature; for to that end, he must have a jolt head, and then he would not have body and blood enough to supply his brain with spirits; or if he had a small head, proportionable to his body, there would not be brain enough for conducting life. But it is still worse with giants; and there could never have been a nation of such, for there would not be food enough found in any country to sustain them; or if there were, beasts sufficient for this purpose, there would not be grass enough for their maintainance. But what is still more, add others, giants could never be able to support the weight of their own bodies; since a man of ten feet high, must be eight times as heavy as one of the ordinary stature; whereas, he has but twice the size of muscles to support such a burthen; and consequently, would be overloaded with the weight of his own body. Such are the theories upon this subject; and they require no other answer, but that experience proves them both to be false: dwarfs are found capable of life and reason; and giants are seen to carry their own bodies. We have several accounts from mariners, that a nation of giants actually exists; and mere speculation



speculation should never induce us to doubt their veracity.

Ferdinand Magellan was the first who discovered this race of people along the coast, towards the extremity of South America. Magellan was a Portuguese of noble extraction, who having long behaved with great bravery under Albuquerque, the conqueror of India, he was treated with neglect by the court, upon his return. Applying, therefore, to the king of Spain, he was entrusted with the command of five ships, to subdue the Molucca islands, upon one of which he was slain. It was in his voyage thither, that he happened to winter in St. Julian's Bay, an American harbour, forty-nine degrees south of the line. In this desolate region, where nothing was seen but objects of terror, where neither trees nor verdure dress the face of the country, they remained for some months without seeing any human creature. They had judged the country to be utterly uninhabitable; when one day, they saw approaching, as if he had been dropt from the clouds, a man of enormous stature, dancing and singing, and putting dust upon his head, as they supposed, in token of peace. This overture for friendship was, by Magellan's command, quickly answered by the rest of his men; and the giant approaching, testified every mark of astonishment and surprise. He was so tall, that the Spaniards only reached his waist; his face was broad, his colour brown, and painted over with a variety of tints; each cheek had the resemblance of an heart drawn upon it; his hair was approaching to whiteness; he was clothed in skins and armed with a bow. Being treated with kindness, and dismissed with some trifling presents, he soon returned, with many more of the same stature, two of whom the mariners decoyed on ship-board: nothing could be more gentle than they were in the beginning; they considered the fetters that were preparing for them, as ornaments, and played with them, like children with their toys; but when they found for what purpose they were intended, they instantly exerted their amazing strength, and broke them in pieces with a very easy effort. This account, with a variety of other circumstances, has been confirmed by succeeding travellers: Herrera, Sebald Werr, Oliver Van Noort, and James le Maire, all correspond in affirming the fact, although they differ in many particulars of their respective descriptions. The last voyager we have had, that has seen this enormous race, is Byron. We can no longer, therefore, refuse our assent to the existence of this gigantic race of mankind; in what manner they are propagated, or under what regulations they live, is a subject that remains for future investigation. It should appear, however, that they are a wandering nation, changing their abode with the course of the sun, and shifting their situation, for the convenience of food, climate, or pasture.

This race of giants are described as possessed of great strength; and, no doubt, they must be very different from those accidental giants that are to be seen in different parts of Europe. Stature with these, seems rather their infirmity than their pride; and adds to their burthen, without increasing their strength. The generality of these were ill-formed and unhealthful; weak in their persons, or incapable of exerting what strength they were possessed of. The same defects of understanding that attended those of suppressed stature, were found in those who were thus overgrown: they were heavy, phlegmatic, stupid, and inclining to sadness. The numbers, however, are but few; and it is thus kindly ordered by Providence, that as the middle state is the best fitted

for happiness, so the middle ranks of mankind are produced in the greatest variety.

However, mankind seems naturally to have a respect for men of extraordinary stature; and it has been a supposition of long standing, that our ancestors were much taller, as well as much more beautiful than we. This has been, indeed, a theme of poetical declamation from the beginning; and man was scarce formed, when he began to deplore an imaginary decay. Nothing is more natural than this progress of the mind, in looking up to antiquity with reverential wonder. Having been accustomed to compare the wisdom of our fathers, with our own in early imbecility, the impression of their superiority remains when they no longer exist, and when we cease to be inferior. Thus the men of every age consider the past as wiser than the present; and the reverence seems to accumulate as our imaginations ascend. For this reason, we allow remote antiquity many advantages, without disputing their title: the inhabitants of uncivilized countries represent them as taller and stronger, and the people of a more polished nation, as more healthy and more wise. Nevertheless, these attributes seem to be only the prejudices of ingenious minds; a kind of gratitude, which we hope in turn to receive from posterity. The ordinary stature of men, Mr. Derham observes, is, in all probability, the same now as at the beginning. The oldest measure we have of the human figure, is in the monument of Cheops, in the first pyramid of Egypt. This must have subsisted many hundred years before the times of Homer, who is the first that deplores the decay. This monument, however, scarce exceeds the measure of our ordinary coffins: the cavity is no more than six feet long, two feet wide, and deep in about the same proportion. Several mummies also, of a very early age, are found to be only of the ordinary stature; and shew that, for these three thousand years at least, men have not suffered the least diminution. We have many corroborating proofs of this, in the ancient pieces of armour which are dug up in different parts of Europe. The brass helmet dug up at Medauro, fits one of our men, and yet is allowed to have been left there at the overthrow of Afrubal. Some of our finest antique statues, which we learn from Pliny and others, to be exactly as big as the life, still continue to this day, remaining monuments of the superior excellence of their workmen, indeed, but not of the superiority of their stature. We may conclude, therefore, that men have been, in all ages, pretty much of the same size they are at present; and that the only difference must have been accidental, or perhaps national.

As to the superior beauty of our ancestors, it is not easy to make the comparison; beauty seems a very uncertain charm; and frequently is less in the object, than in the eye of the beholder. Were a modern lady's face formed exactly like the Venus of Medici, or the sleeping Venetian, she would scarce be considered beautiful, except by the lovers of antiquity, whom, of all her admirers perhaps, she would be least desirous of pleasing. It is true, that we have some disorders among us, that disfigure the features, and from which the ancients were exempt; but it is equally true, that we want some which were common among them, and which were equally deforming. As for their intellectual powers, these also were probably the same as ours: we excel them in the sciences, which may be considered as an history of accumulated experience; and they excel us in the poetic arts, as they had the first rising of all the striking images of Nature.



## C H A P. XIII.

## Containing a particular Account of MUMMIES, WAX-WORKS, &amp;c.

**M**AN is not content with the usual term of life, but he is willing to lengthen out his existence by art; and although he cannot prevent death, he tries to obviate his dissolution. It is natural to attempt to preserve even the most trifling relicks of what has long given us pleasure; nor does the mind separate from the body, without a wish, that even the wretched heap of dust it leaves behind, may yet be remembered. The embalming, practised in various nations, probably had its rise in this fond desire: an urn filled with ashes, among the Romans, served as a pledge of continuing affection; and even the grassy graves in our own churchyards, are raised above the surface, with the desire that the body below should not be wholly forgotten. The soul, ardent after eternity for itself, is willing to procure, even for the body, a prolonged duration.

But of all nations, the Egyptians carried this art to the highest perfection: as it was a principle of their religion, to suppose the soul continued only coeval to the duration of the body, they tried every art to extend the life of the one, by preventing the dissolution of the other. In this practice they were exercised from the earliest ages; and the mummies they have embalmed in this manner, continue in great numbers to the present day. We are told, in Genesis, that Joseph seeing his father expire, gave orders to his physicians to embalm the body, which they executed in the compass of forty days, the usual time of embalming. Herodotus also, the most ancient of the profane historians, gives us a copious detail of this art, as it was practised, in his time, among the Egyptians. There are certain men among them, says he, who practice embalming as a trade; which they perform with all expedition possible. In the first place, they draw out the brain through the nostrils, with irons adapted to this purpose; and in proportion as they evacuate it in this manner, they fill up the cavity with aromatics; they next cut open the belly, near the sides, with a sharpened stone, and take out the entrails, which they cleanse, and wash in palm oil: having performed this operation, they roll them in aromatic powder, fill them with myrrh, cassia, and other perfumes, except incense: and replace them, sewing up the body again. After these precautions, they salt the body with nitre, and keep it in the salting-place for seventy days, it not being permitted to preserve it so any longer. When the seventy days are accomplished, and the body washed once more, they swathe it in bands made of linen, which have been dipt in a gum the Egyptians use instead of salt. When the friends have taken back the body, they make an hollow trough, something like the shape of a man, in which they place the body; and this they inclose in a box, preserving the whole as a most precious relick, placed against the wall. Such are the ceremonies used with regard to the rich; as for those who are contented with an humbler preparation, they treat them as follows: they fill a syringe with an odoriferous liquor extracted from the cedar tree, and, without making an incision, inject it up the body of the deceased, and then keep it in nitre, as long as in the former case. When the time is expired,

they evacuate the body of the cedar liquor which had been injected; and such is the effect of this operation, that the liquor dissolves the intestines, and brings them away; the nitre also serves to eat away the flesh; and leaves only the skin and the bones remaining. This done, the body is returned to the friends, and the embalmer takes no farther trouble about it. The third method of embalming those of the meanest condition, is merely by purging and cleansing the intestines by frequent injections, and preserving the body for a similar term in nitre, at the end of which it is restored to the relations.

Diodorus Siculus also, makes mention of the manner in which these embalmings are performed. According to him, there were several officers appointed for this purpose: the first of them, who was called the scribe, marked those parts of the body, on the left side, which were to be opened; the cutter made the incision; and one of those that were to salt it, drew out all the bowels, except the heart and the kidneys; another washed them in palm-wine, and odoriferous liquors; afterwards they anointed for above thirty days, with cedar, gum, myrrh, cinnamon, and other perfumes. These aromatics preserved the body entire for a long time, and gave it a very agreeable odour. It was not in the least disfigured by this preparation; after which it was returned to the relations, who kept it in a coffin, placed upright against the wall.

Most of the modern writers who have treated on this subject, have merely repeated what has been said by Herodotus; and if they add any thing of their own, it is but merely from conjecture. Dumont observes, that it is very probable, that aloes, bitumen, and cinnamon, make a principal part of the composition, which is used on this occasion: he adds, that after embalming, the body is put into a coffin, made of the sycamore-tree, which is almost incorruptible. Mr. Grew remarks, that in an Egyptian mummy, in the possession of the Royal Society, the preparation was so penetrating, as to enter into the very substance of the bones, and rendered them so black, that they seemed to have been burnt. From this he is induced to believe, that the Egyptians had a custom of embalming their dead, by boiling them in a kind of liquid preparation, until all the aqueous parts of the body were exhaled away; and until the oily or gummy matter had penetrated throughout. He proposes, in consequence of this, a method of macerating, and afterwards of boiling the dead body in oil of walnut.

We are of opinion, that there were several ways of preserving dead bodies from putrefaction; and that this would be no difficult matter, since different nations have all succeeded in the attempt. We have an example of this kind among the Guanches, the ancient inhabitants of the island of Teneriff. Those who survived the general destruction of this people, by the Spaniards, when they conquered this island, informed them, that the art of embalming was still preserved there; and that there was a tribe of priests among them, possessed of the secret, which they kept concealed as



a sacred mystery. As the greatest part of the nation was destroyed, the Spaniards could not arrive at a complete knowledge of this art; they only found out a few of the particulars. Having taken out the bowels, they washed the body several times in a lee made of the dried bark of the pine-tree, warmed, during the summer, by the sun, or by a stove in the winter. They afterwards anointed it with butter, or the fat of bears, which they had previously boiled with odoriferous herbs, such as sage and lavender. After this unction, they suffered the body to dry, and then repeated the operation, as often as it was necessary, until the whole substance was impregnated with the preparation. When it was become very light, it was then a certain sign that it was fit, and properly prepared. They then rolled it up in the dried skins of goats; which, when they had a mind to save expence, they suffered to remain with the hair still growing upon them. Purchas assures us, that he has seen mummies of this kind in London; and mentions the name of a gentleman who had seen several of them in the island of Teneriff, which were supposed to have been two thousand years old; but without any certain proofs of such great antiquity. This people, who probably came first from the coasts of Africa, might have learned this art from the Egyptians, as there was a traffic carried on from thence into the most internal parts of Africa.

Father Acoſta, and Garcilasso de la Vega, make no doubt but that the Peruvians understood the art of preserving their dead for a very long space of time. They assert their having seen the bodies of several Incas, that were perfectly preserved. They still preserved their hair, and their eye-brows; but they had eyes, made of gold, put in the places of those taken out. They were clothed in their usual habits, and seated in the manner of the Indians, their arms placed on their breasts. Garcilasso touched one of their fingers, and found it apparently as hard as wood; and the whole body was not heavy enough to over-burthen a weak man, who should attempt to carry it away. Acoſta presumes, that these bodies were embalmed with a bitumen, of which the Indians knew the properties. Garcilasso, however, is of a different opinion, as he saw nothing bituminous about them; but he confesses, that he did not examine them very particularly; and he regrets his not having enquired into the methods used for that purpose. He adds, that, being a Peruvian, his countrymen would not have scrupled to inform him of the secret, if they really had it still among them.

Garcilasso, thus being ignorant of the secret, makes use of some inductions, to throw light upon the subject; he asserts, that the air is so dry and so cold at Cusco, that flesh dries there like wood, without corrupting; and he is of opinion, that they dried the body in snow, before they applied the bitumen: he adds, that in the times of the Incas, they usually dried the flesh which was designed for the army; and that when they had lost their humidity, they might be kept without salt, or any other preparation.

It is said, that at Spitzbergen, which lies within the arctic circle, and, consequently, in the coldest climate, bodies never corrupt, nor suffer any apparent alteration, even though buried for thirty years; nothing corrupts, or putrefies in that climate; the wood which has been employed in building those houses where the train-oil is separated, appears as fresh as the day they were first cut.

If excessive cold, therefore, be thus capable of preserving bodies from corruption, it is not less certain, that a great degree of dryness, produced by heat, produces the same effect. It is well

known, that the men and animals that are buried in the sands of Arabia, quickly dry up, and continue in preservation for several ages, as if they had actually been embalmed. It has often happened, that whole caravans have perished in crossing those deserts, either by the burning winds that infect them, or by the sands which are raised by the tempest, and overwhelm every creature in certain ruin. The bodies of those persons are preserved entire; and they are often found in this condition by some accidental passenger. Many authors, both ancient and modern, make mention of such mummies as these: and Shaw says, that he has been assured, that numbers of men, as well as other animals, have been thus preserved for times immemorial, in the burning sands of Saibah, which is a place, he supposes, situate between Ralem and Egypt.

The corruption of dead bodies, being entirely caused by the fermentation of the humours, whatever is capable of hindering or retarding this fermentation, will contribute to their preservation. Both heat and cold, though so contrary in themselves, produce similar effects in this particular, by drying up the humours. The cold in condensing and thickening them, and the heat in evaporating them before they have time to act upon the solids. But it is necessary that these extremes should be constant; for if they succeed each other so as that cold shall follow heat, or dryness humidity, it must then necessarily happen, that corruption must ensue. However, in temperate climates, there are natural causes capable of preserving dead bodies; among which we may reckon the qualities of the earth in which they are buried. If the earth be drying and astringent, it will imbibes the humidity of the body; and it may be, probably for this reason, that the bodies buried in the monastery of the Cordeliers, at Thoulouse, do not putrefy, but dry in such a manner that they may be lifted up by one arm.

The gums, resins, and bitumens, with which dead bodies are embalmed, keep off the impressions which they would else receive from the alteration of the temperature of the air; and still more, if a body thus prepared be placed in a dry or burning sand, the most powerful means will be united for its preservation. We are not to be surprised, therefore, at what we are told by Chardin, of the country of Chorasan, in Persia. The bodies, which have been previously embalmed, and buried in the sands of that country, as he assures us, are found to petrify, or, in other words, to become extremely hard, and are preserved for several ages. It is asserted that some of them have continued for a thousand years.

The Egyptians, as has been mentioned above, swathed the body with linen bands, and enclosed it in a coffin; however, it is probable that, with all these precautions, they would not have continued till now, if the tombs, or pits, in which they were placed, had not been dug in a dry chalky soil, which was not susceptible of humidity; and which was, besides, covered over with a dry sand of several feet thickness.

The sepulchres of the ancient Egyptians subsist to this day. Most travellers who have been in Egypt, have described those of ancient mummies, and have seen the mummies interred there. These catacombs are within two leagues of the ruins of this city, nine leagues from Grand Cairo, and about two miles from the village of Zaccara. They extend from thence to the pyramids of Pharaoh, which are about eight miles distant. These sepulchres lie in a field, covered with a fine running sand, of a yellowish colour. The country is dry and hilly; the entrance of the tomb is choaked



choaked up with sand; there are many open, but several more that are still concealed. The inhabitants of the neighbouring village have no other commerce, or method of subsisting, but by seeking out mummies, and selling them to such strangers as happen to be at Grand Cairo. This commerce, some years ago, was not only a very common, but a very gainful one. A complete mummy was often sold for twenty pounds; but it must not be supposed that it was bought at such a high price from a mere passion for antiquity; there were much more powerful motives for this traffic. Mummy at that time made a considerable article in medicine; and a thousand imaginary virtues were ascribed to it, for the cure of most disorders, particularly of the paralytic kind. There was no shop, therefore, without mummy in it; and no physician thought he had properly treated his patient, without adding this to his prescription. Induced by the general reputation, in which this supposed drug was at that time, several Jews, both of Italy and France, found out the art of imitating mummy so exactly, that they, for a long time, deceived all Europe. This they did by drying dead bodies in ovens, after having prepared them with myrrh, aloes, and bitumen. Still, however, the request for mummies continued, and a variety of cures were daily ascribed to them. At length, Paræus wrote a treatise on their total inefficacy in physic; and shewed their abuse in loading the stomach, to the exclusion of more efficacious medicines.

From that time, their reputation began to decline; the Jews discontinued their counterfeits, and the trade returned entire to the Egyptians, when it was no longer of value. The industry of seeking after mummies is now totally relaxed, their price merely arbitrary, and just what the curious are willing to give.

In seeking for mummies, they first clear away the sand, which they may do for weeks together, without finding what is wanted. Upon coming to a little square opening, of about eighteen feet in depth, they descend into it, by holes for the feet, placed at proper intervals; and there they are sure of finding what they seek for. These caves, or wells, as they call them, are hollowed out of a white freestone, which is found in all this country a few feet below the covering of sand.

When one gets to the bottom of these, which are sometimes forty feet below the surface, there are several square openings, on each side, into passages of ten or fifteen feet wide, and these lead to chambers of fifteen or twenty feet square. These are all hewn out of the rock; and in each of the catacombs are to be found several of these apartments, communicating with each other. They extend a great way under ground, so as to be under the city of Memphis, and in a manner to undermine its environs.

In some of the chambers, the walls are adorned with figures and hieroglyphics; in others, the mummies are found in tombs, round the apartment hollowed out in the rock. These tombs are upright, and cut into the shape of a man, with his arms stretched out. There are others found, and these in the greatest number, in wooden coffins, or in cloths covered with bitumen. These coffins, or wrappers, are covered all over with a variety of ornaments. There are some of them painted, and adorned with figures, such as that of death, and the leaden seals, on which several characters are engraven.

Some of these coffins are carved into the human shape; but the head alone is distinguishable; the rest of the body is all of a piece, and terminated

by a pedestal, while there are some with their arms hanging down; and it is by these marks that the bodies of persons of rank are distinguished from those of the meaner order. There are generally found lying on the floor, without any profusion of ornaments; and in some chambers the mummies are found indiscriminately piled upon each other, and buried in the sand.

Many mummies are found lying on their backs; their heads turned to the north, and the hands placed on the belly. The bands of linen, with which these are swathed, are found to be more than a thousand yards long; and, of consequence, the number of circumvolutions they make about the body must have been amazing. These were performed by beginning at the head, and ending at the feet; but they contrived it so as to avoid covering the face. However, when the face is entirely uncovered, it moulders into dust immediately upon the admission of the air. When, therefore, it is preserved entire, a slight covering of cloth is so disposed over it, that the shape of the eye, the nose, and the mouth, are seen under it. Some mummies have been found with a long beard, and hair that reached down to the mid-leg; nails of a surprising length, and some gilt, or at least painted of a gold colour. Some are found with bands upon the breast, covered with hieroglyphics, in gold, silver, or in green; and some with tutelary idols, and other figures of jasper, within their body. A piece of gold, also, has often been found under their tongues, of about two pistoles value; and, for this reason, the Arabians spoil all the mummies they meet with, in order to get at the gold.

But, although art, or accident, has thus been found to preserve dead bodies entire, it must by no means be supposed that it is capable of preserving the exact form and lineaments of the deceased person. Those bodies which are found dried away in the Deserts, or in some particular church-yards, are totally deformed, and scarce any lineaments remain of their external structure. Nor are the mummies preserved by embalming, in a better condition. The flesh is dried away, hardened, and hidden under a variety of bandages; the bowels, as we have seen, are totally removed; and from hence, in the most perfect of them, we see only a shapeless mass of skin discoloured, and even the features scarce distinguishable. The art is, therefore, an effort rather of preserving the substance than the likeness of the deceased; and has, consequently, not been brought to its highest pitch of perfection. It appears from a mummy, not long since dug up in France, that the art of embalming was more completely understood in the western world than even in Egypt. This mummy, which was dug up at Auvergne, was an amazing instance of their skill, and is one of the most curious relics in the art of preservation. As some peasants, in that part of the world, were digging in a field near Rion, within about twenty-six paces of the highway, between that and the river Artier, they discovered a tomb, about a foot and a half beneath the surface. It was composed only of two stones; one of which formed the body of the sepulchre, and the other the cover. This tomb was of free-stone; seven feet and a half long, three feet and a half broad, and about three feet high. It was of rude workmanship; the cover had been polished, but was without figure or inscription: within this tomb was placed a leaden coffin, four feet seven inches long, fourteen inches broad, and fifteen high. It was not made in the form of a coffin, but oblong, like a box, equally broad at both ends, and covered with a lid that fitted on like a snuff-box, without an hinge. This cover had two holes in it, each of about



about two inches long, and very narrow, filled with a substance resembling butter; but for what purpose intended remains unknown. Within this coffin was a mummy, in the highest and most perfect preservation. The internal sides of the coffin were filled with an aromatic substance, mingled with clay. Round the mummy was wrapped a coarse cloth, in form of a napkin, under this were two shirts, or shrouds, of the most exquisite texture; beneath these a bandage, which covered all parts of the body, like an infant in swaddling cloaths; still, under this general bandage there was another, which went particularly round the extremities, the hands and the legs. The head was covered with two caps; the feet and hands were without any particular bandages; and the whole body was covered with an aromatic substance, an inch thick. When these were removed, and the body exposed naked to view, nothing could be more astonishing than the preservation of the whole, and the exact resemblance it bore to a body that had been dead a day or two before. It appeared well proportioned, except that the head was rather large, and the feet small. The skin had all the pliancy and colour of a body lately dead; the visage, however, was of a brownish hue. The belly yielded to the touch; all the joints were flexible; except those of the legs and feet; the fingers stretched forth of themselves when bent inwards. The nails still continued entire; and all the marks of the joints, both in the fingers, the palms of the hands, and the soles of the feet, remained perfectly visible. The bones of the arms and legs were soft and pliant; but, on the contrary, those of the skull preserved their rigidity; the hair, which only covered the back of the head, was of a chestnut colour, and about two inches long. The pericranium at top was separated from the skull, by an incision, in order to open it for the introducing proper aromatics in the place of the brain, where they were found mixed with clay. The teeth, the tongue, and the ears, were all preserved in perfect form. The intestines were not taken out of the body, but remained pliant and entire, as in a fresh subject; and the breast was made to rise and fall like a pair of bellows. The embalming preparation had a very strong and pungent smell, which the body preserved for more than a month after it was exposed to the air. This odour was perceived wherever the mummy was laid; although

it remained there but a very short time, it was even pretended that the peasants of the neighbouring villages were incommoded by it. If one touched either the mummy, or any part of the preparation, the hands smelt of it several hours after, although washed with water, spirit of wine, or vinegar. This mummy, having remained exposed for some months to the curiosity of the public, began to suffer some mutilations. A part of the skin of the forehead was cut off; the teeth were drawn out, and some attempts were made to pull away the tongue. It was, therefore, put into a glass-case, and shortly after transmitted to the king of France's cabinet, at Paris.

There are many reasons to believe this to be the body of a person of the highest distinction; however, no marks remain to assure us either of the quality of the person, or the time of his decease. There only are to be seen some irregular figures on the coffin; one of which represents a kind of star. There were also some singular characters upon the bandages, which were totally defaced by those who had torn them away. However, it should seem that it had remained for several ages in this state, since the first years immediately succeeding the interment, are usually those in which the body is most liable to decay. It appears also to be a much more perfect method of embalming than that of the Egyptians; as in this the flesh continues with its natural elasticity and colour, the bowels remain entire, and the joints have almost the pliancy which they had when the person was alive. Upon the whole, it is probable that a much less tedious preparation than that used by the Egyptians would have sufficed to keep the body from putrefaction; and that an injection of petroleum inwardly, and a layer of asphaltum without, would have sufficed to have made a mummy; and it is remarkable that Auvergne, where this was found, affords these two substances in sufficient plenty. This art, therefore, might be brought to greater perfection than it has arrived at hitherto, were the art worth preserving. But mankind have long since grown wiser in this respect, and think it unnecessary to keep by them a deformed carcass, which, instead of aiding their magnificence, must only serve to mortify their pride.



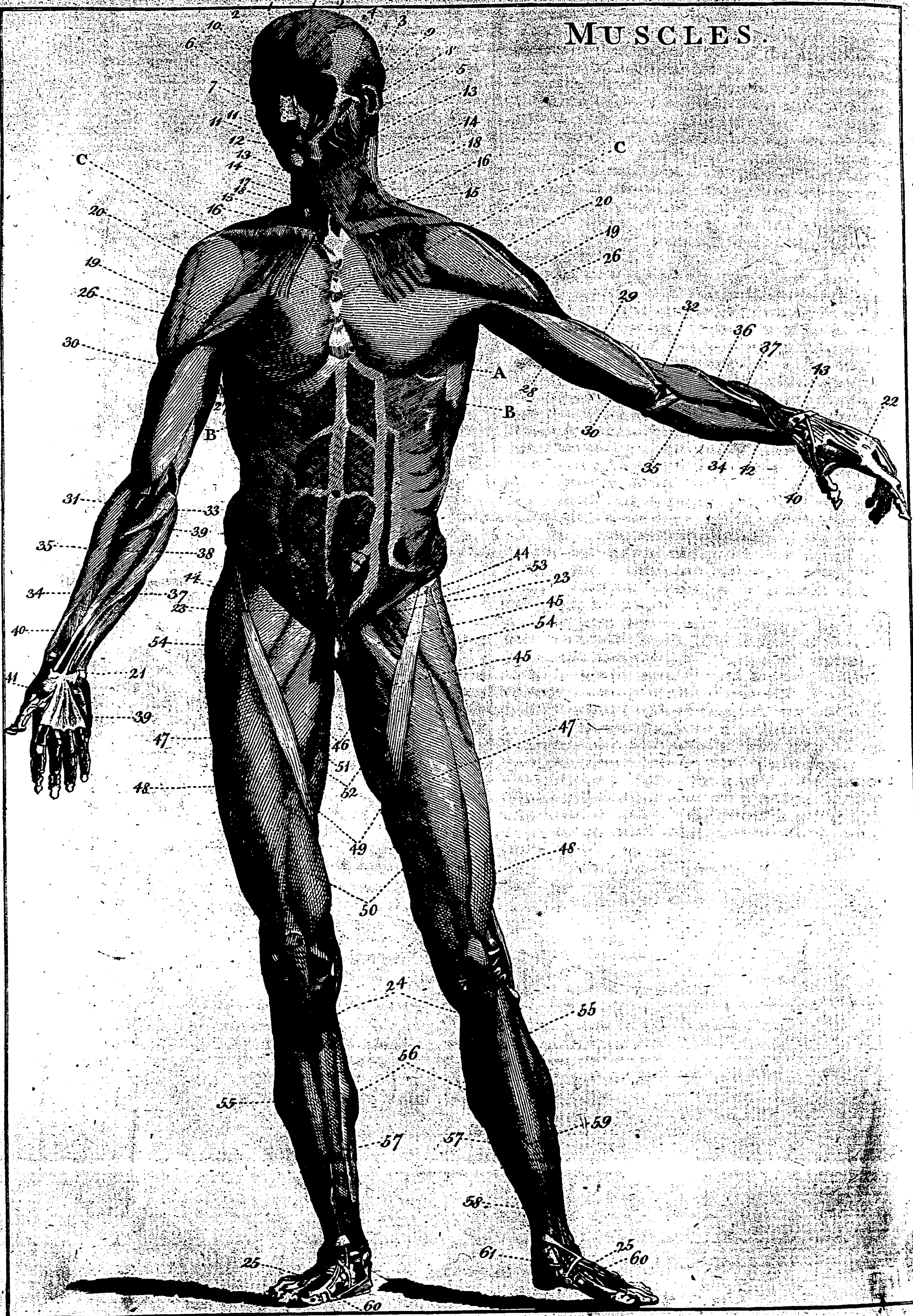
## APPENDIX





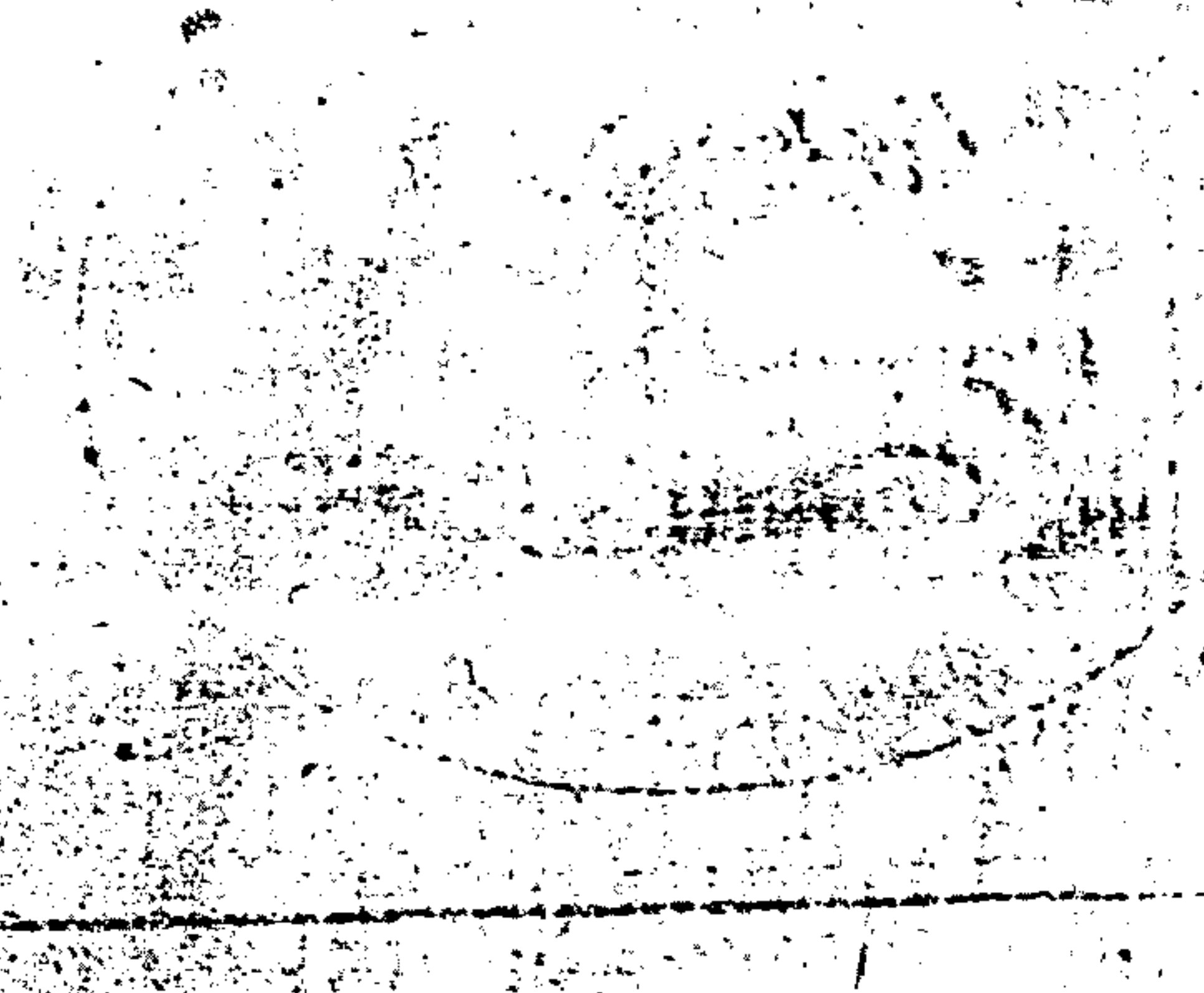
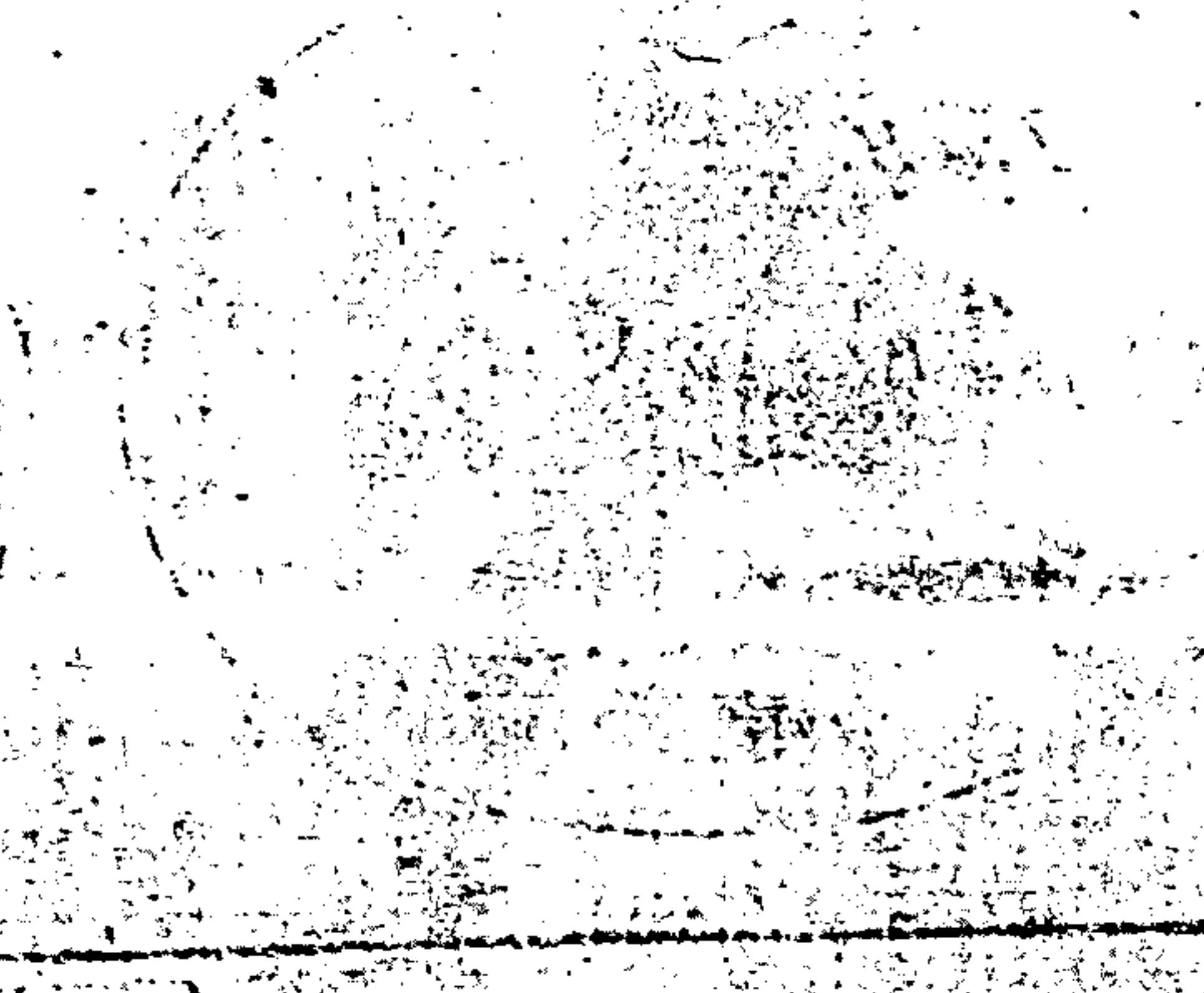
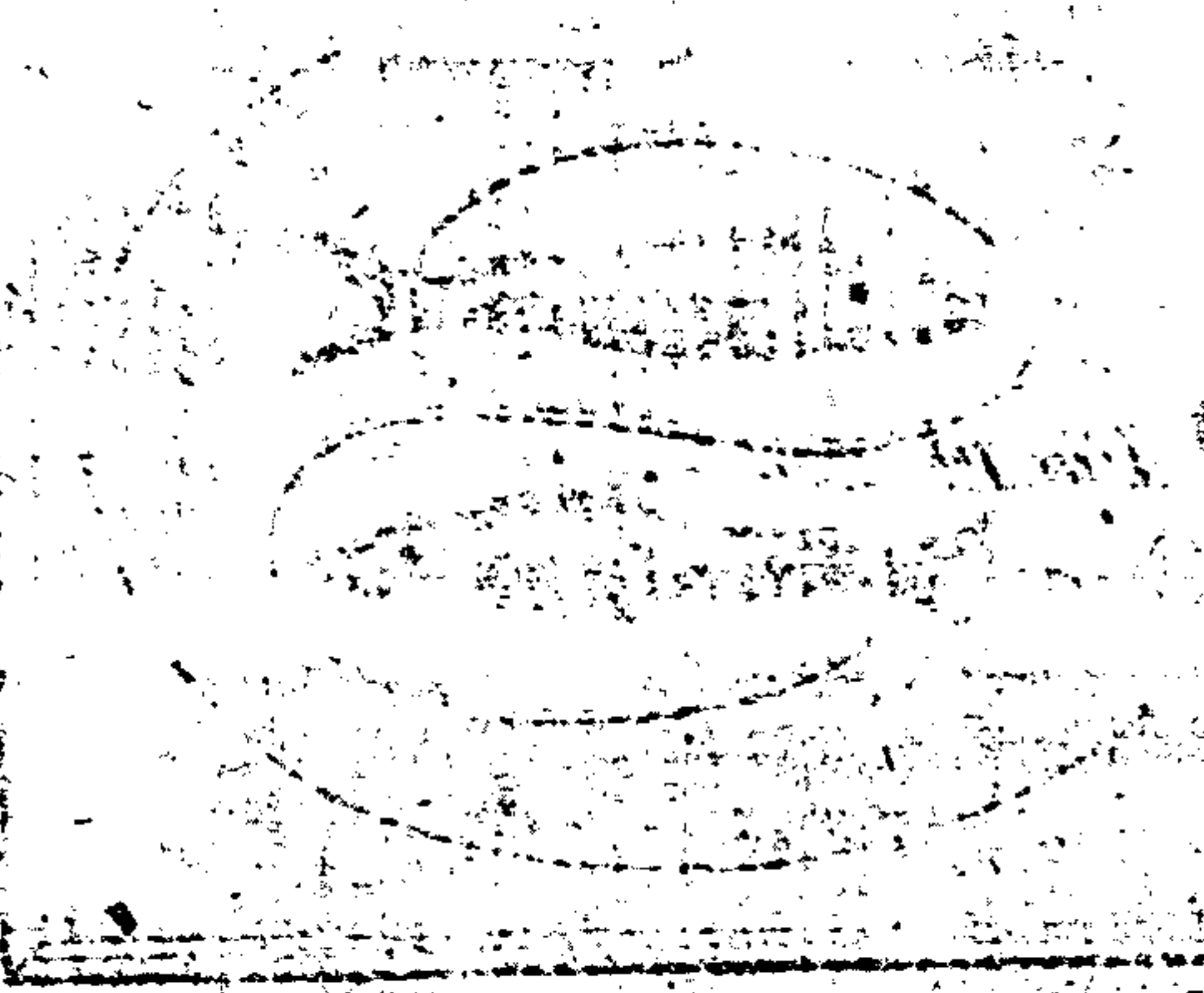
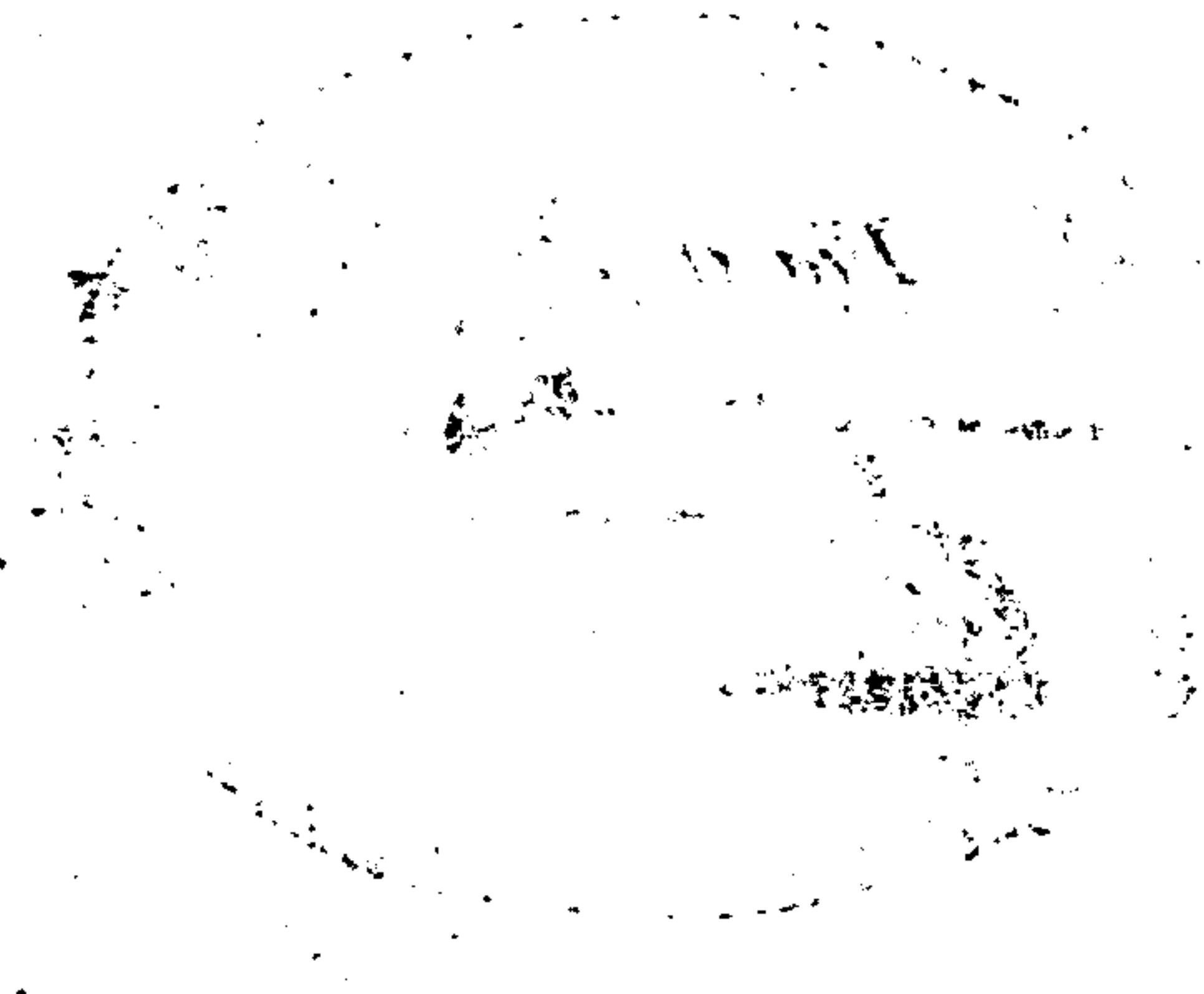
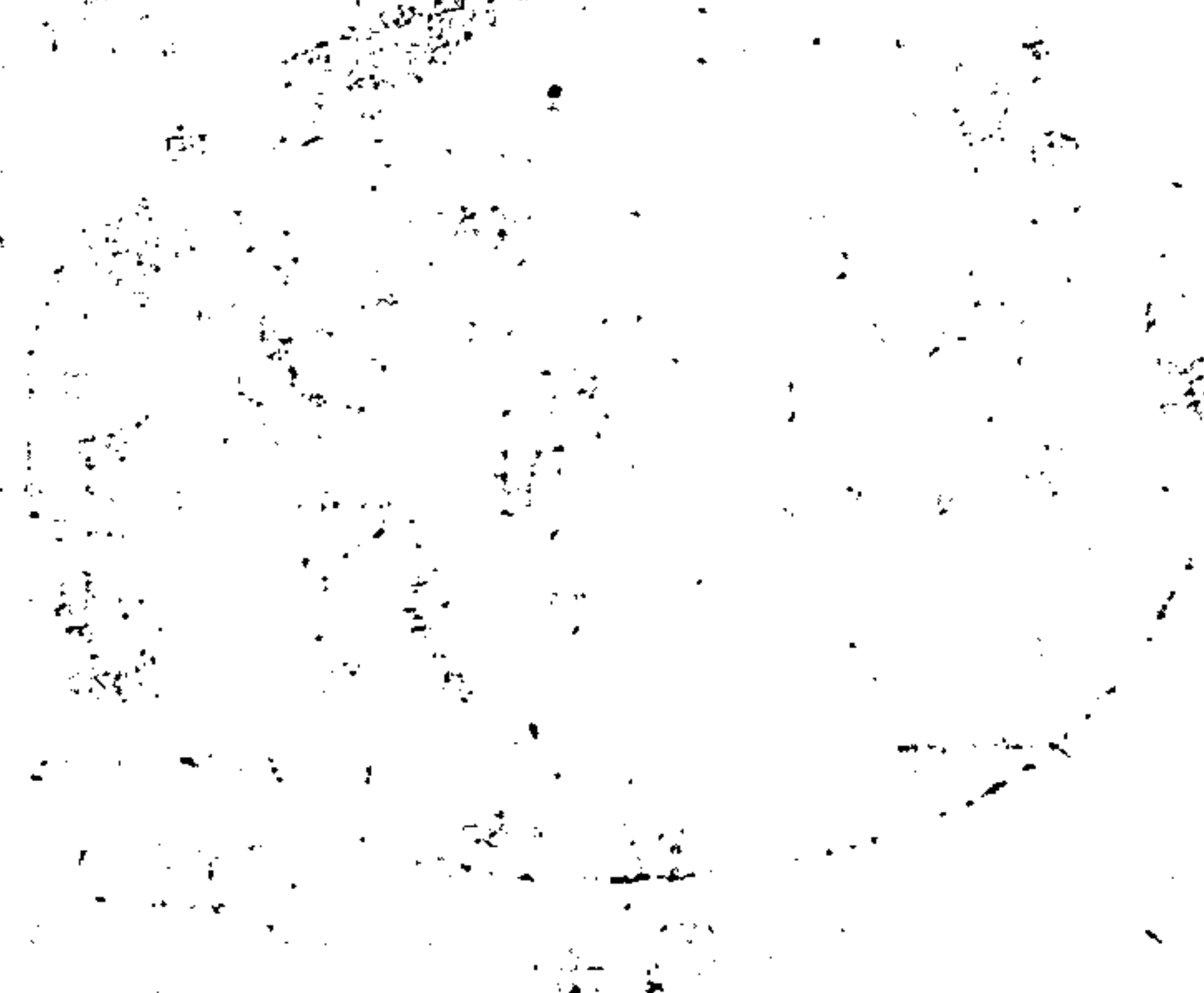
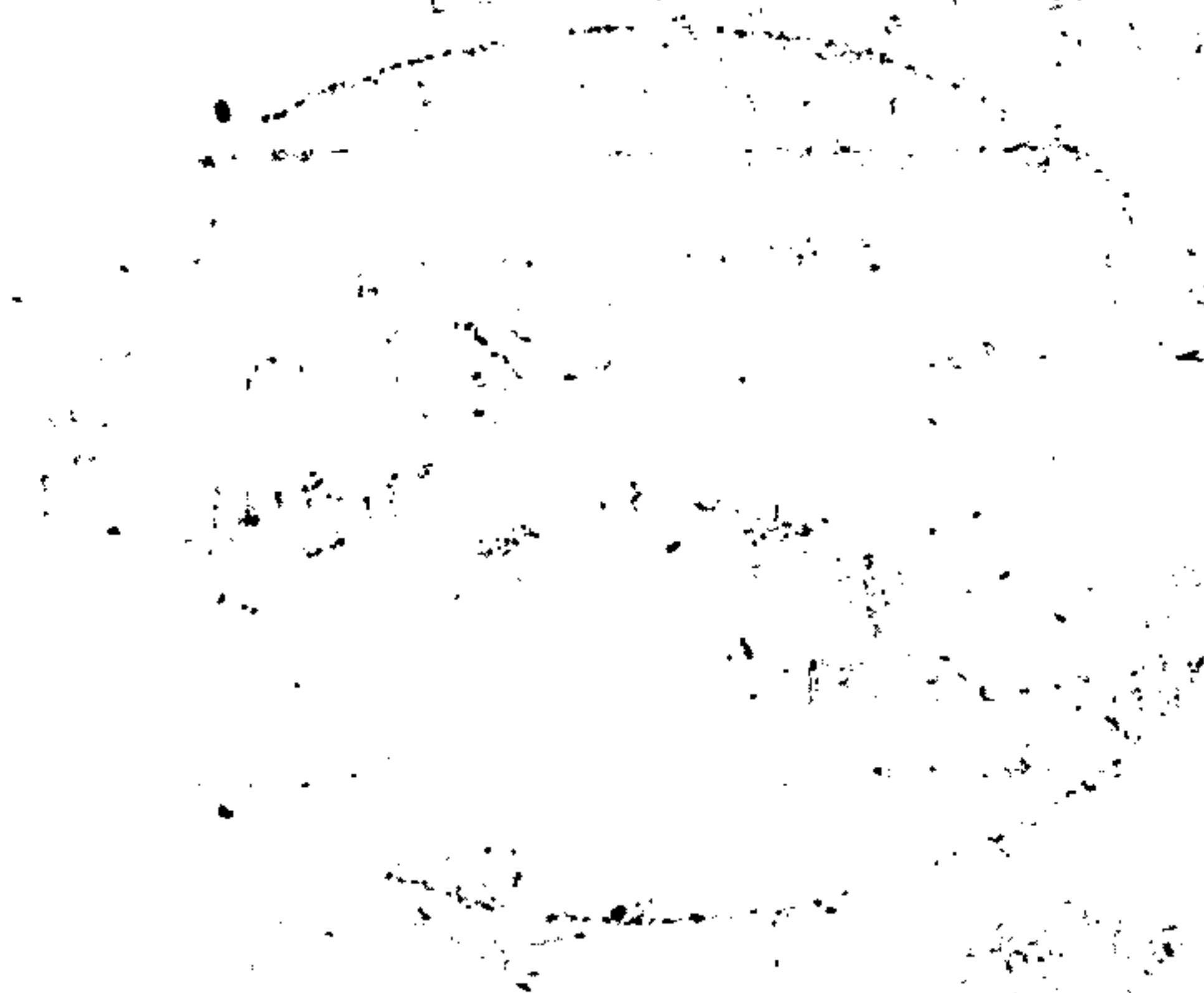
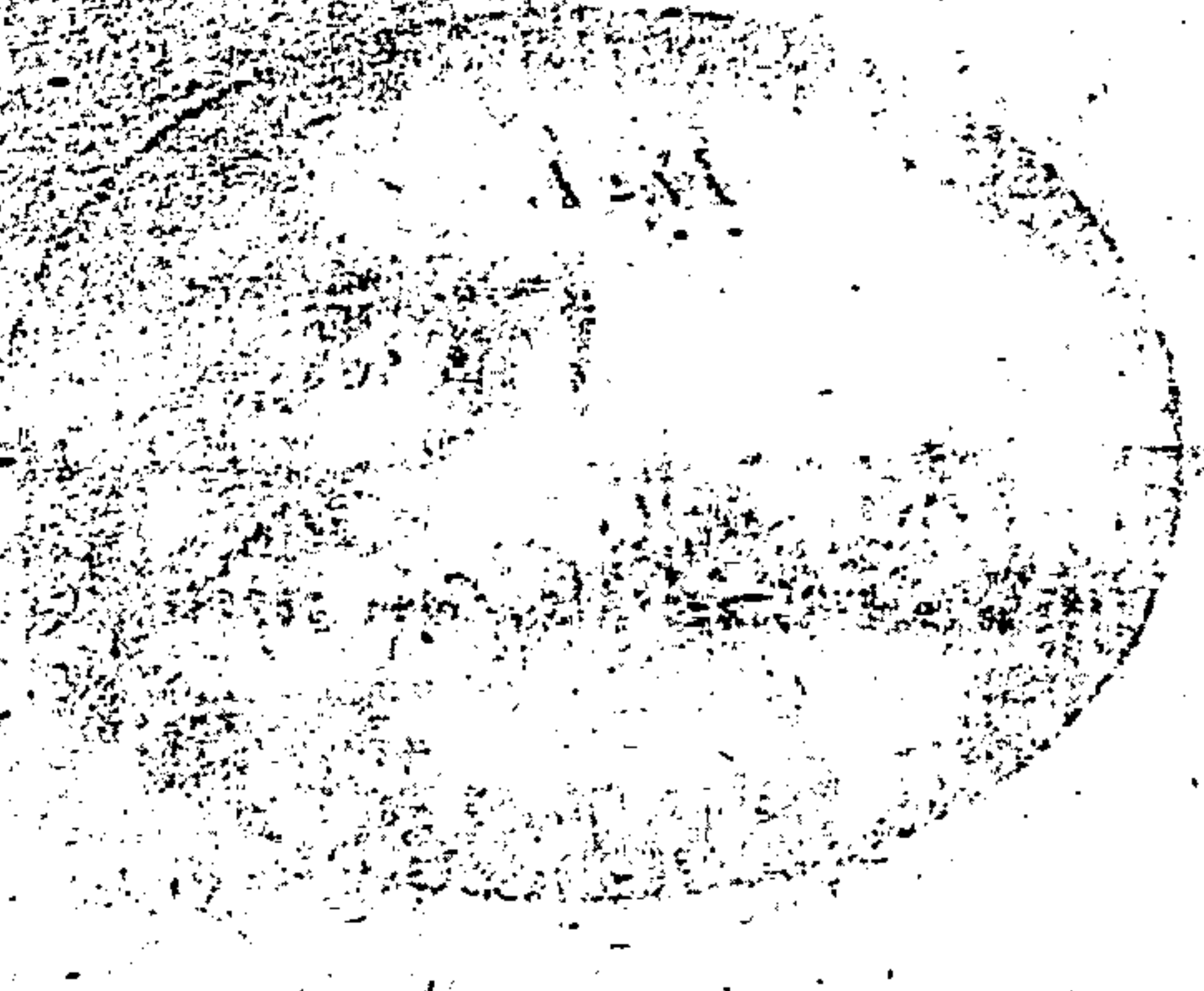
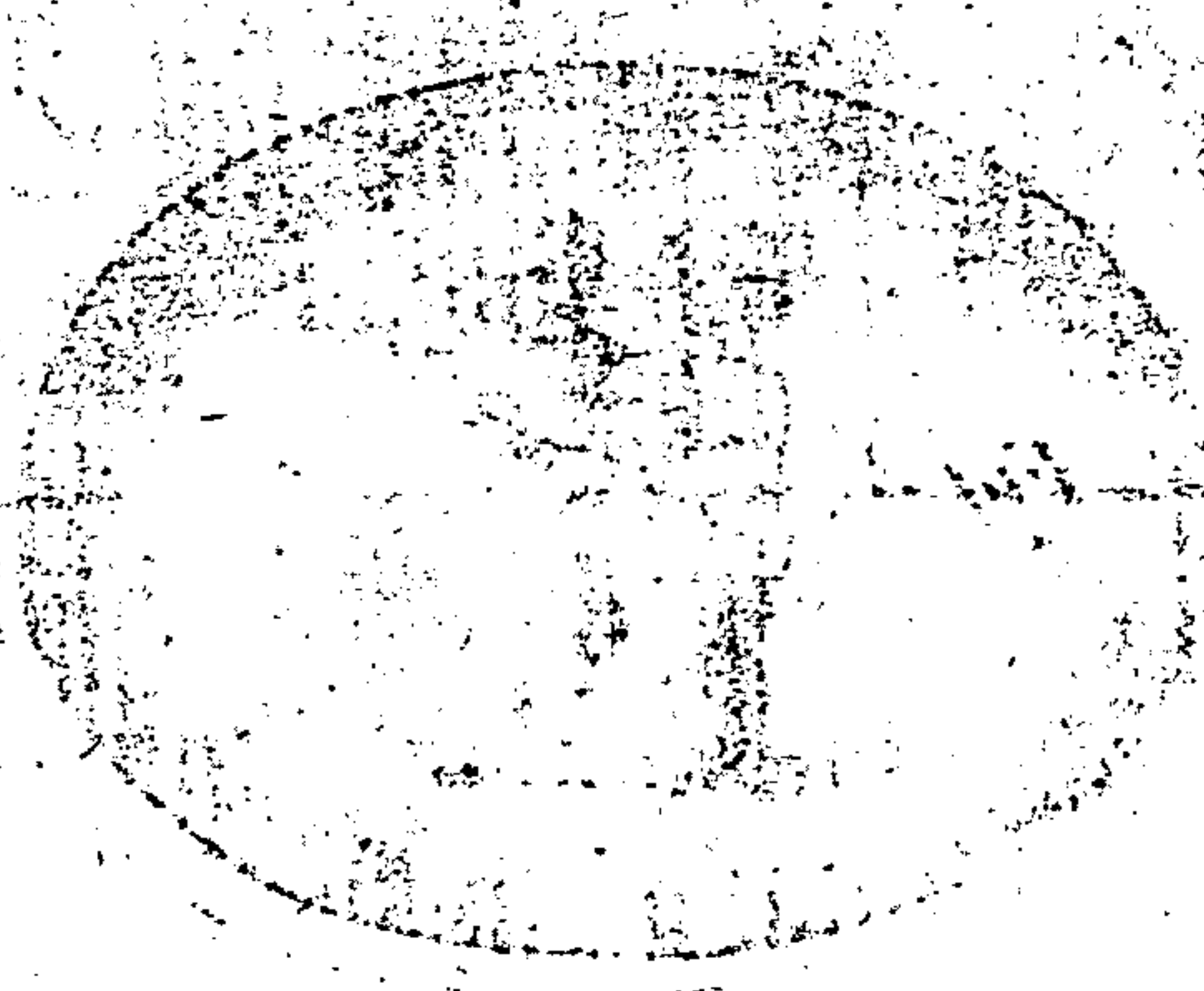


# MUSCLES.





NOTES





# ZODIAC

*Aries*



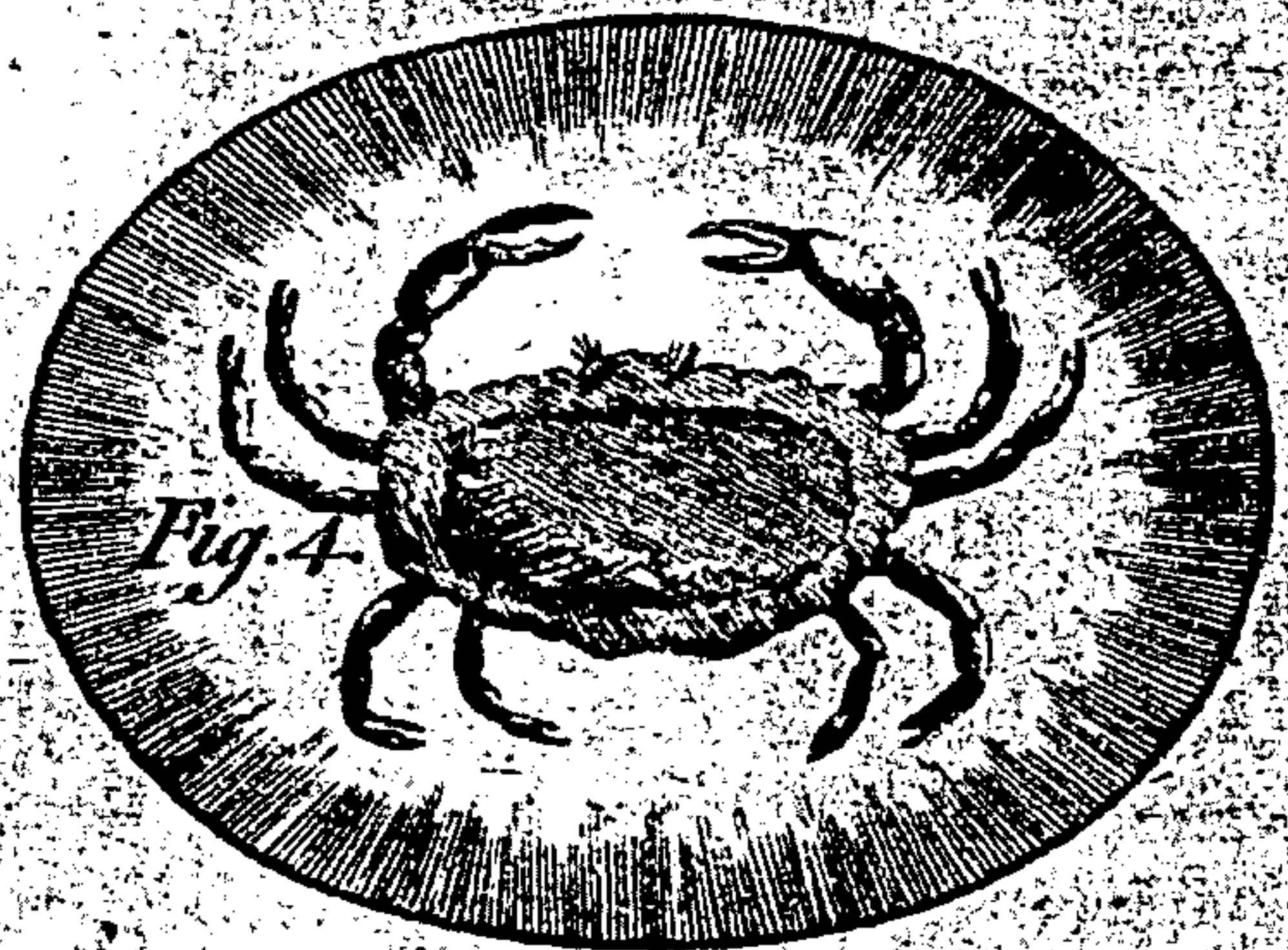
*Taurus*



*Gemini*



*Cancer*



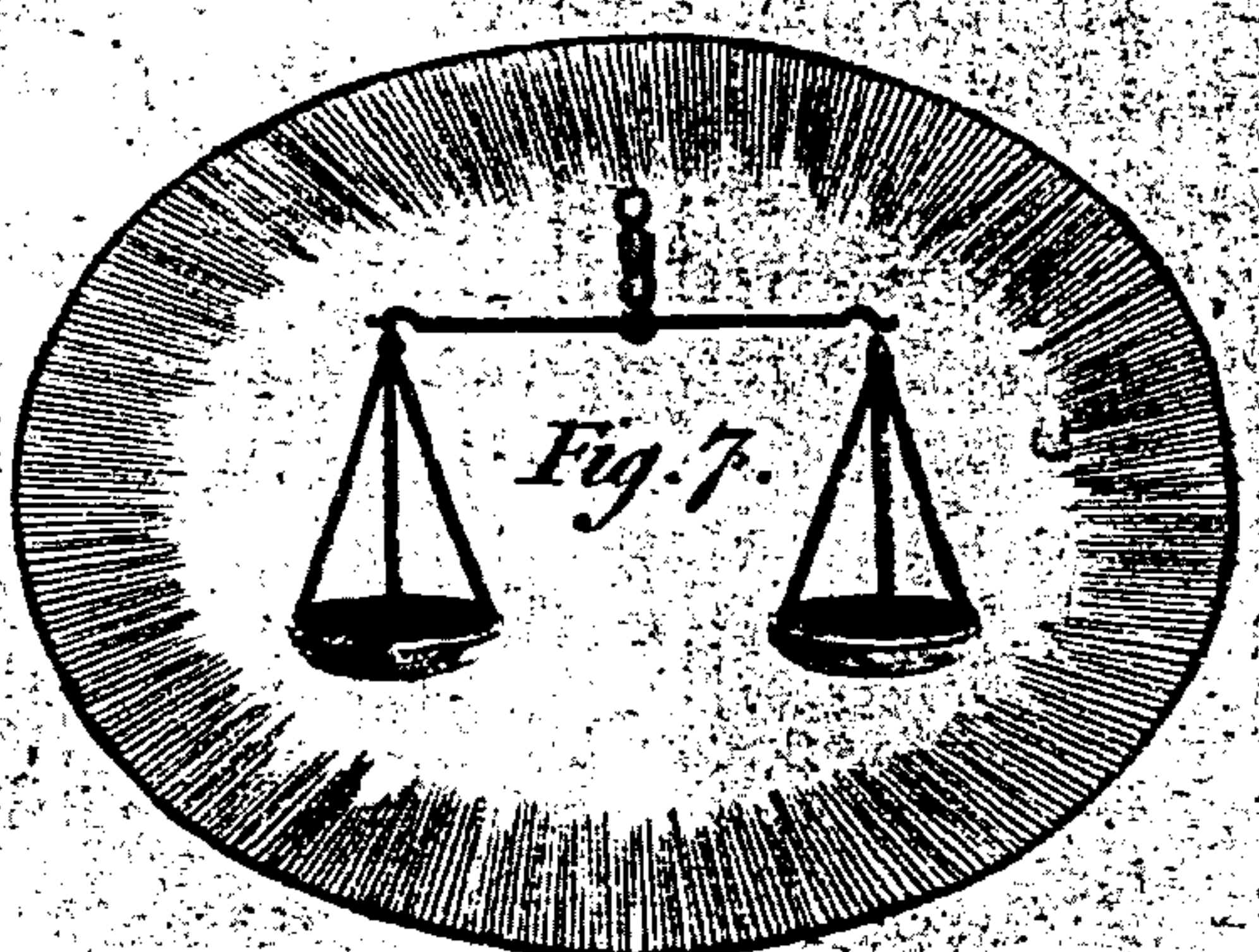
*Leo*



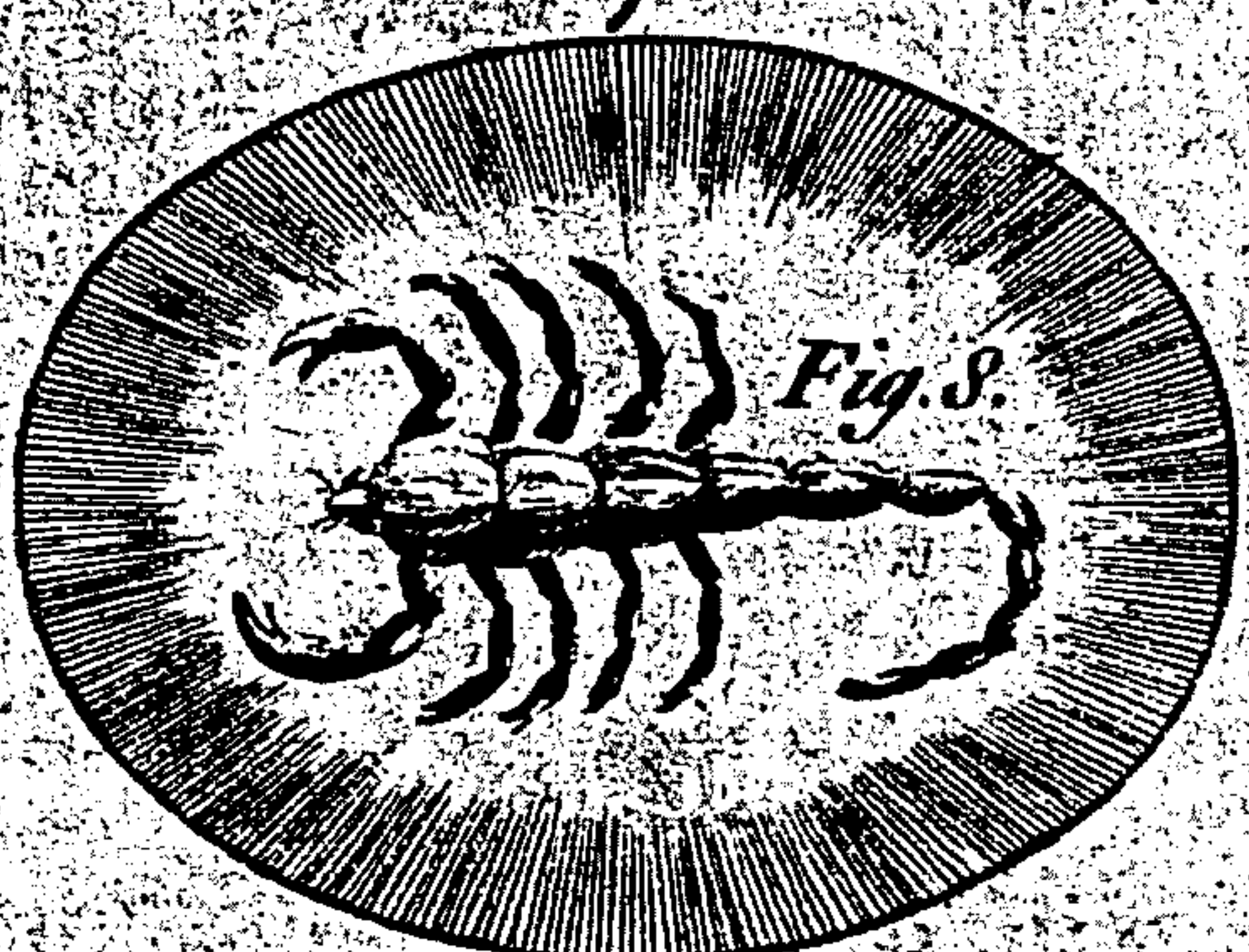
*Virgo*



*Libra*



*Scorpio*



*Sagittarius*



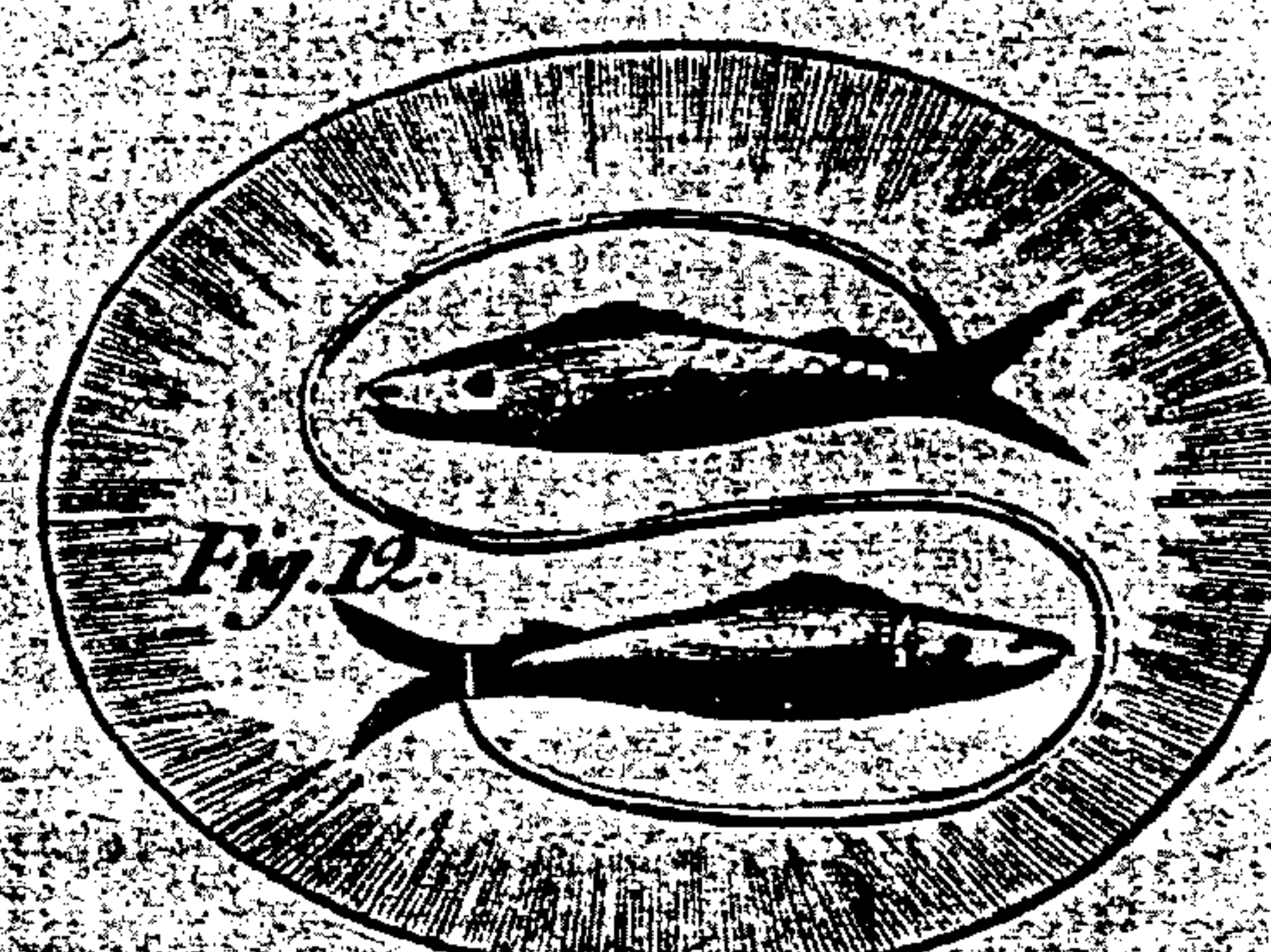
*Capricornus*



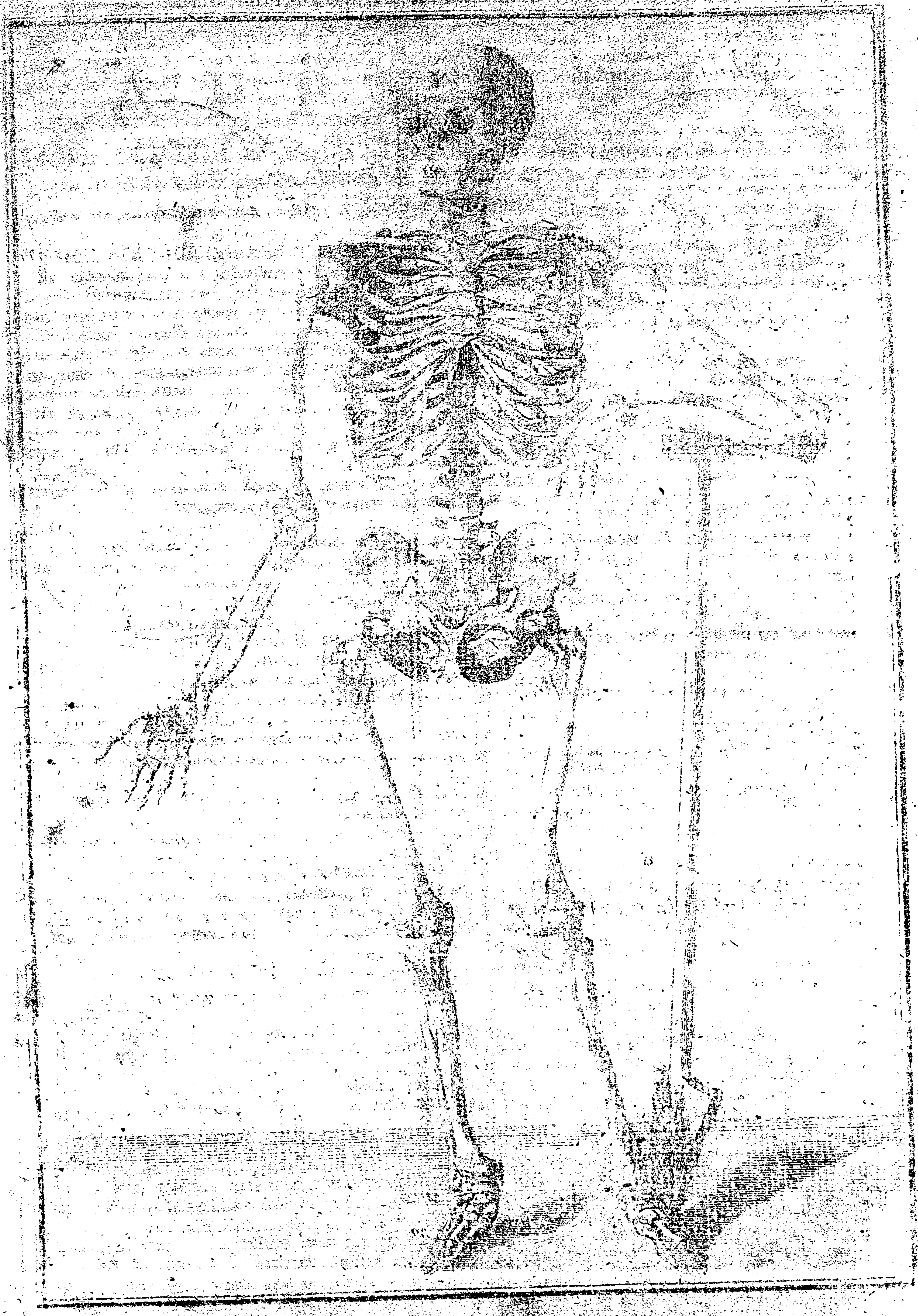
*Aquarius*



*Pisces*

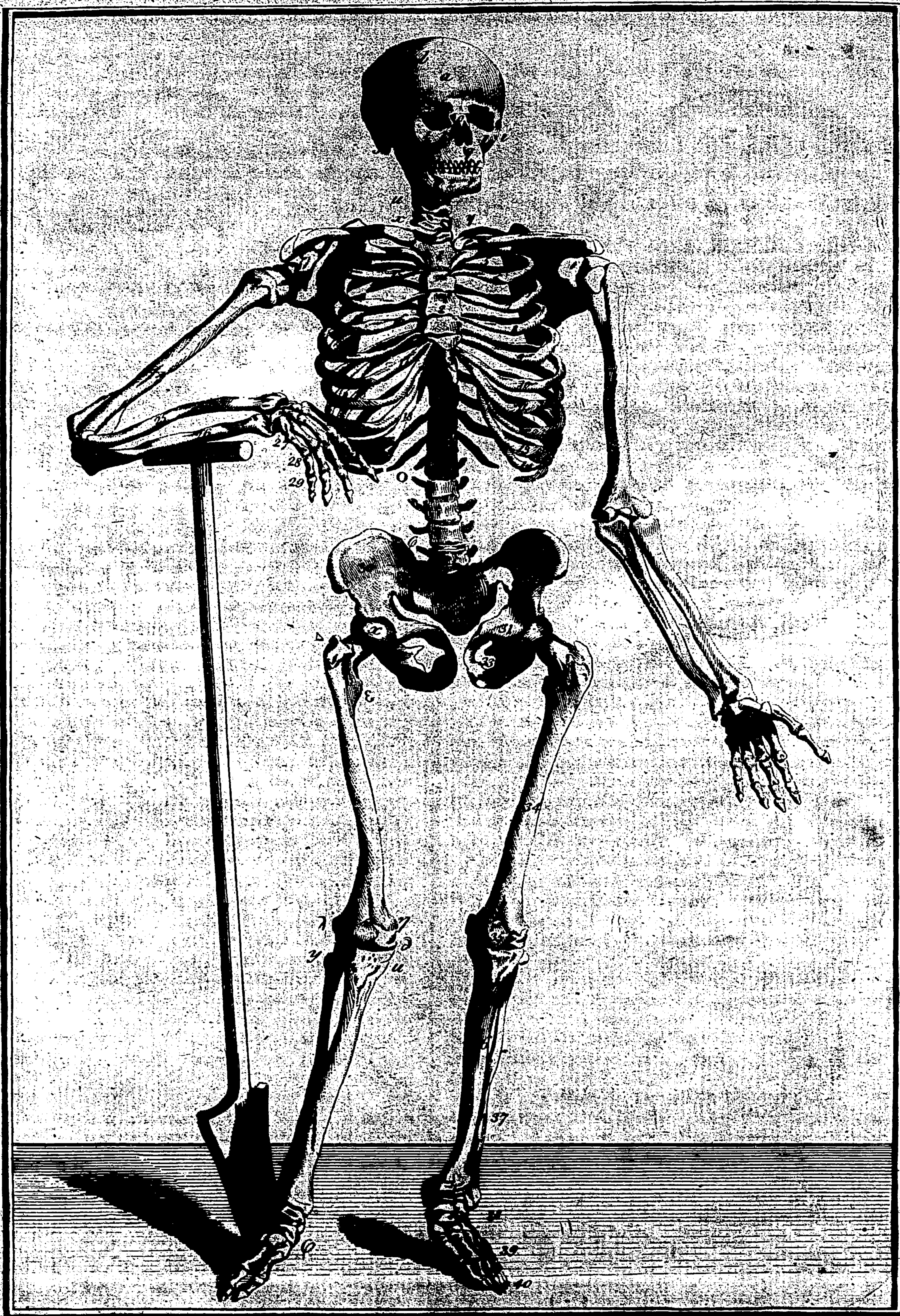








# SKELETON.





# APPENDIX.

In our SKETCH of the UNIVERSE, in Page 477, the Printer having omitted to mention our Plate containing the twelve Signs of the Zodiac—we shall here insert the following Explanation:

**THE ZODIACK** is one of the greatest imaginary circles of the heavens, which passes obliquely between the two poles of the world; it is cut into two equal parts, by the equator, one of which comprehends the six northern signs towards the Arctick pole, and the other the six southern signs towards the Antartick pole; it is furnished with twelve constellations represented upon globes, by the figure of twelve living creatures. The sun goes about this circle once every year, and the moon once a month, and in the middle of it is the Ecliptick line, from which the sun never departs; but the moon and planets wander up and down from the space of eight degrees, and sometimes more in both.

*Figure 1.* Shews **ARIES**, a constellation in the heavens represented by a ram, which is the first sign of the zodiack. The number of stars in this constellation, are 18 in Ptolemy's catalogue, 21 in Tycho's, and 65 in Mr. Flamsteed's.

*Fig. 2.* Is **TAURUS**, the bull, and is thus characterised, ♉. The stars in the constellation Taurus, in Ptolemy's catalogue, are 44; in Tycho's catalogue, 41; in the Britannick catalogue, 135.

*Fig. 3.* Is **GEMINI**, the Twins, represented by two beautiful children, embracing and looking very affectionately in the face of each other, and is thus marked ♊.

The poets say they represent Castor and Pollux, sons to Jupiter and Leda. The stars of Gemini in Ptolemy's catalogue contain 24; in Tycho's 29; in the Britannick catalogue 89.

*Fig. 4.* Is **CANCER**, represented on the globe in the form of a crab, and thus marked, ♋. Ptolemy makes it contain only 13 stars; Tycho Brahe 15; Bayer and Hevelius 29; and Flamsteed no less than 71.

*Fig. 5.* Is **LEO**, containing, according to Ptolemy, 32 stars; according to Tycho, 37; and according to Flamsteed, 94.

The famous star of the first magnitude, called *ba-filicus*, *regulus*, *cor-leonis*, or the lion's heart, is in this constellation.

*Fig. 6.* Is **VIRGO**, in which the sun enters in the middle of August. The stars in the constellation Virgo, in Ptolemy's catalogue, are 32; in Tycho's 39; in the Britannick, 89.

*Fig. 7.* Is **LIBRA**, or the balance, so called, because when the sun enters it, the days and nights are equal, as if weighed in a balance.

*Fig. 8.* Is **SCORPIO**, *Scorpion*, denoted by this character, ♏. The stars in Scorpio in Ptolemy's catalogue, are 20; in that of Tycho, 10; but in that of Mr. Flamsteed, 49.

*Fig. 9.* Is **SAGITTARIUS**, the archer, marked thus, ♐. The stars in this constellation in Ptolemy's catalogue are 31; in Tycho's 16, and in Mr. Flamsteed's 52.

*Fig. 10.* Is **CAPRICORNUS**, or *Capricorn*, represented on the globe in the form of a goat, with a fish's tail. It is marked thus, ♑. According to Ptolemy and Tycho, it contains 19 stars; according to Hevelius 29, and according to Flamsteed 58.

This constellation is very properly represented by No. 58.

the wild goat, whose nature being to seek its food from the bottom to the top of mountains, climbing from rock to rock, fitly emblemized the ascent of the sun, from the lowest point, in the beginning of this sign to its highest pitch or summit, in the summer solstice.

*Fig. 11.* Is **AQUARIUS**, a constellation, marked thus, ♒. This constellation, consists of 45 stars in Ptolemy's catalogue, of 49 in Tycho's, and in Mr. Flamsteed's of 108.

*Fig. 12.* Is **PISCES**, marked thus, ♓. The stars in Pisces, in Ptolemy's catalogue, are 38; in Tycho's, 33; and in the Britannick catalogue, 109.

In our NATURAL HISTORY of MAN have been also omitted, Explanations of several Plates belonging to this Work. We shall therefore give them as follow:

## Explanation of the Plate representing the Skeleton of the Human Body.

*a*, The frontal bone. *b*, The coronal suture. *c*, The parietal bone. *d*, The occipital suture. *e*, The temporal bone. *f*, The mastoid apophysis. *g*, The zygomatic apophysis. *h*, The temporal apophysis. *i*, The bones of the cheek. *k*, The external part of the bone that lines the orbits of the eye. *l*, The os planum. *m*, The os unguis. *n*, The upper apophysis of the maxillary bone. *o*, The bone of the nose. *p*, The partition of the nose. *q*, The maxillary bone. *r*, The lower jaw. *s*, The orbit of the eye. *t*, The inferior part of the orbit. *u*, The fifth vertebrae of the neck. *x*, The sixth. *y*, The hole of their transverse apophysis. *z*, The chin. *1*, *2*, *3*, The sternum. *4*, The clavicles. *5*, *6*, *7*, *8*, *9*, *10*, *11*, The true ribs. *12*, *13*, *14*, The false ribs. *15*, *16*, *17*, *18*, The cartilages which unite the true ribs to the sternum. *19*, The last vertebrae of the back. *20*, *21*, The five vertebrae of the loins. *22*, Their transverse apophysis. *23*, The sacrum. *24*, The orifice of the os sacrum. *25*, The amplat. *26*, The humerus, or bone of the arm. *27*, The radius. *28*, The os cubitus. *29*, The carpus. *30*, The metacarpus. *31*, The phalanges, or bones of the fingers. *32*, The os ilium. *33*, The os pubis. *34*, The os ischium. These three last bones compose the ossa innominata. *35*, The foramen ovale. *36*, The os femoris. *37*, Its head. *38*, Its neck. *39*, The great trochanter. *40*, The little trochanter. *41*, The internal condyle. *42*, The external condyle. *43*, The rotula. *44*, The tibia. *45*, The external condyle. *46*, The internal condyle. *47*, The ligament of rotula. *48*, The malleolus internus. *49*, The fibula. *50*, The malleolus externus. *51*, The tarsus. *52*, The metatarsus. *53*, The phalanges of the toes.

## Explanation of the Plate representing a Front View of the Muscles.

*1*, *1*, The muscoli frontales. *2*, *2*, The orbicularis palpebrarum. *3*, The arrector supercilii. *4*, The



4. The temporalis. 5. The masseter. 6. Represents the muscle called by Lancisi constrictor, or depressor pinnae narium. 7. The dilatator alae nasi. 8. The zygomaticus. 9. The place of the elevator labiorum, or elevator labiorum communis, called by Lancisi gracilis. 10. The elevator labii superioris proprius. 11, 11. The constrictor or sphincter labiorum, or orbicularis labiorum; by some called osculatorius. 12. The buccinator. 13, 13. The muscoli mastoidei. 14, 14. The sternohyoidei. 15, 15. Those parts of these muscles which arise from the clavicle. 16, 16. The coracohyoidei. 17. The scaleni. 18. Represents part of the cucullaris on the right side. 18. On the left side is the levator or elevator scapulae, otherwise called musculus patientiae. 19, 19. The place where the fibres of the pectoralis unite, in some measure, with those of the deltoides. 20, 20. The deltoides. 21. The place in the carpus, where the palmaris longus passes through a ring in the annular ligament. 22. A remarkable union of the tendons of the extensors of the three last fingers. 23, 23. The productions of the peritonæum, which, perforating the muscles of the abdomen at the rings descend to the scrotum. 24, 24. The place where the three tendons of the sartorius, gracilis, and semitendinosus are inserted into the anterior and internal part of the tibia, just under the knee. 25, 25. The tendons of the extensors of the toes, which are secured by a ligament at the ankle, as appears on both sides. But on the right side internally another ligament is represented, which fixes the tendons of the extensor longus digitorum, the tibialis posticus, and the flexor pollicis. 26, 26. The musculus pectoralis. 27. The triceps extensor cubiti on the right side. 28, and 30. The biceps on the left side, according to Lancisi's explication. 29. Part of the triceps extensor on the left side. 30. The biceps on the right side. 31. The brachialis internus. 32. The anconeus. 33. The pronator rotundus. 34, 34. The supinator longus. 35, 35. The radius externus, according to Lancisi. 36. The extensor carpi ulnaris. 37, 37. The cubitæus interus, according to Lancisi. 38. The radius internus, according to Lancisi. 39. The palmaris, with its tendinous expansion. 40, 40. The tendons of the muscles of the thumb. 41. The tendon of the adductor pollicis. 42. The extensor magnus digitorum. 43. Ligamentum carpi. 44, 44. The tendons of the ilioci interni. 45. The pectinæus. 46. One of the heads of the triceps. 47, 47. The rectus femoris on each side. 48, 48. The vastus externus on each side. 49. The vastus internus on each side. 50. The gracilis. 51. The semitendinosus. 52. The sartorius on each side. 53. A part of the origin of the vastus externus. 54, 54. The membranousus. 55, 55. The tibialis anticus. 56. The gemelli. 57, 57. The solæi. 58. The tendo Achillis. 59. According to Lancisi, is the extensor digitorum longus. 60, 60. The tendons of the extensors of the toes. 61. The tendons of the extensor longus, tibialis posticus, and flexor pollicis. A, A. Portions of the latissimus dorsi on each side. B, B. The indentations of the serratus major anticus. C, C. The sternum.

*Explanation of the Plate representing a Back View of the Muscles.*

1. Two muscles upon the occiput called by Eustachius quadrati. 2. The musculus cucullaris. 3. The splenius. 4. The musculus mastoideus. 5. The musculus patientiae, or levator scapulae proprius. 6. The rhomboides. 7. The articulation of the clavicle with the scapula on the right side. 8. The deltoides. 9. The teres minor. 10. The teres major. 11, 11. The latissimus dorsi on each

side. 12. The glutæus major. 13. The glutæus medius. 14. The musculus pyramiformis. 15. The quadratus femoris. 16. The biceps femoris. 17. The semi-membranosus. 18. The membranousus, according to Lancisi. 19, 19. The vasti externi. 20. The gastrocnemii. 21. The soleus. 22. The plantaris.

*Explanation of the Plate of Arteries.*

Fig. 1. Will give a much better idea of the arteries of the human body, than is possible to be conveyed by words.

1. The aorta cut from its origin at the left ventricle of the heart. Fig. 3. of the same plate, represents part of the trunk of the aorta turned inside out; *a, a*, the internal, or nervous coat; *b, b*, the muscular coat; *c*, the external, or vascular coat.

A. The three semi-lunar valves of the aorta, as they appear when they hinder the blood from coming back into the left ventricle of the heart, in its diastole.

2. 2. The trunk of the coronary arteries arising from the aorta.

3. Ligamentum arteriosum.

4. 4. The subclavian arteries.

5. 5. The two carotid arteries.

6. 6. The two vertebral arteries, which arise from the subclavicular, and pass through all the transverse processes of the vertebrae of the neck.

7. 7. The arteries which convey blood to the lower part of the face, tongue, adjacent muscles and glands.

8. 8. The trunks of the temporal arteries, springing from the carotids, and giving branches to the parotid glands.

9. 9. Branches of the temporal arteries, conveying blood to the neighbouring muscles, the hairy scalp, and forehead.

10. 10. The trunks which send blood to the foramina narium, particularly to the glands of its mucous membranes.

11. 11. The occipital arteries, whose trunks pass close by the mamiform process.

12. 12. Muscles which carry blood to the fauces, gargarion, and muscles of those parts.

B. B. Small portions of the basis of the skull, perforated by the artery of the dura mater, part of which is represented as hanging to the arteries.

13. 13. The contortions of the carotid arteries before they pass the basis of the skull to the brain.

14. 14. These parts of the carotid arteries, where they pass by each side of the sella turcica, where several small branches arise from them, and help to compose the rete mirabile.

C. The glandula pituitaria, taken out of the sella turcica, lying between the two contorted trunks of the carotid arteries, marked 14. 14.

D. D. The arteriæ ophthalmicae, which spring from the carotids before they enter the pia mater.

15. The contortions of the vertebral arteries, as they pass the transverse processes of the first vertebra of the neck, towards the os occipitis.

16. The two trunks of the vertebral arteries that lie on the medulla oblongata.

17. The communicant branches between the carotid and cervical artery.

18. 18. The ramifications of the arteries within the skull, the larger trunks of which lie between the lobes of the brain, and its sulci.

E. E. The arteries of the cerebellum.

19. 19. The arteries of the larynx, thyroid glands and adjacent muscles and parts arising from the subclavian arteries.

20. 20. Others arising near the former, which convey blood to the muscles of the neck and scapula.

21. 21. The



# ARTERIES.

Fig. 1.

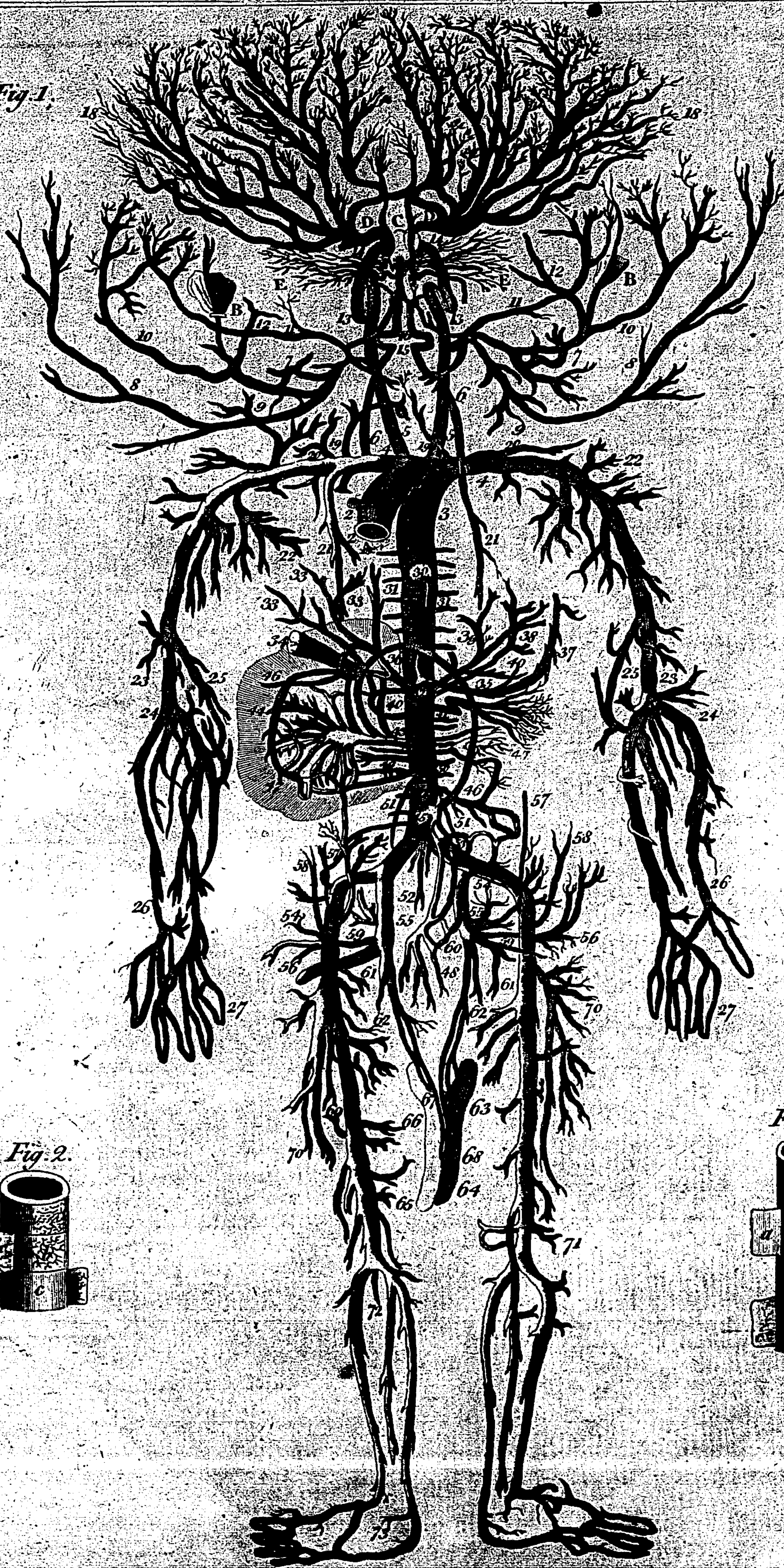


Fig. 2.

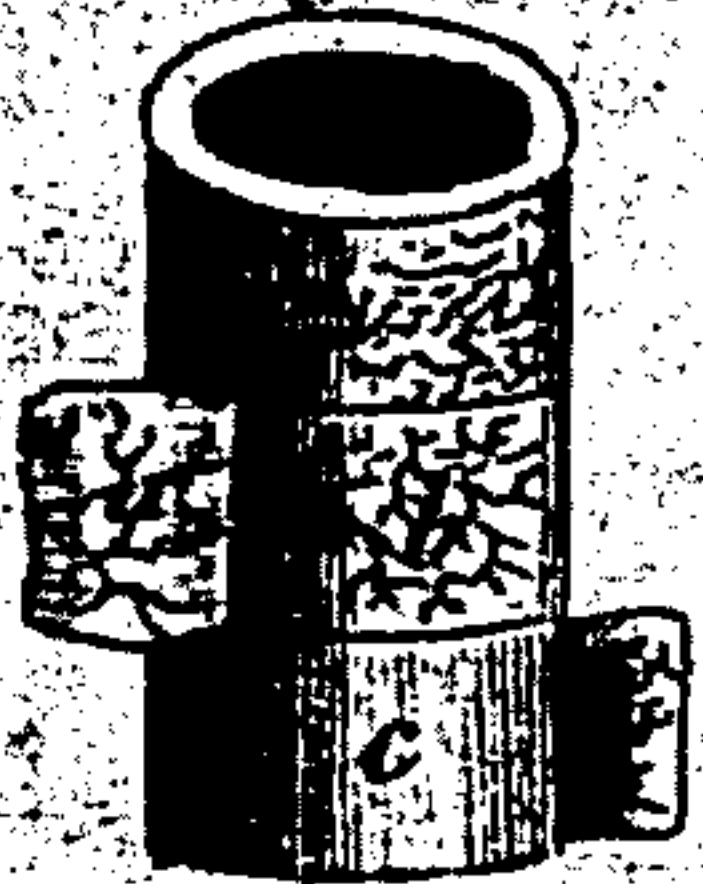
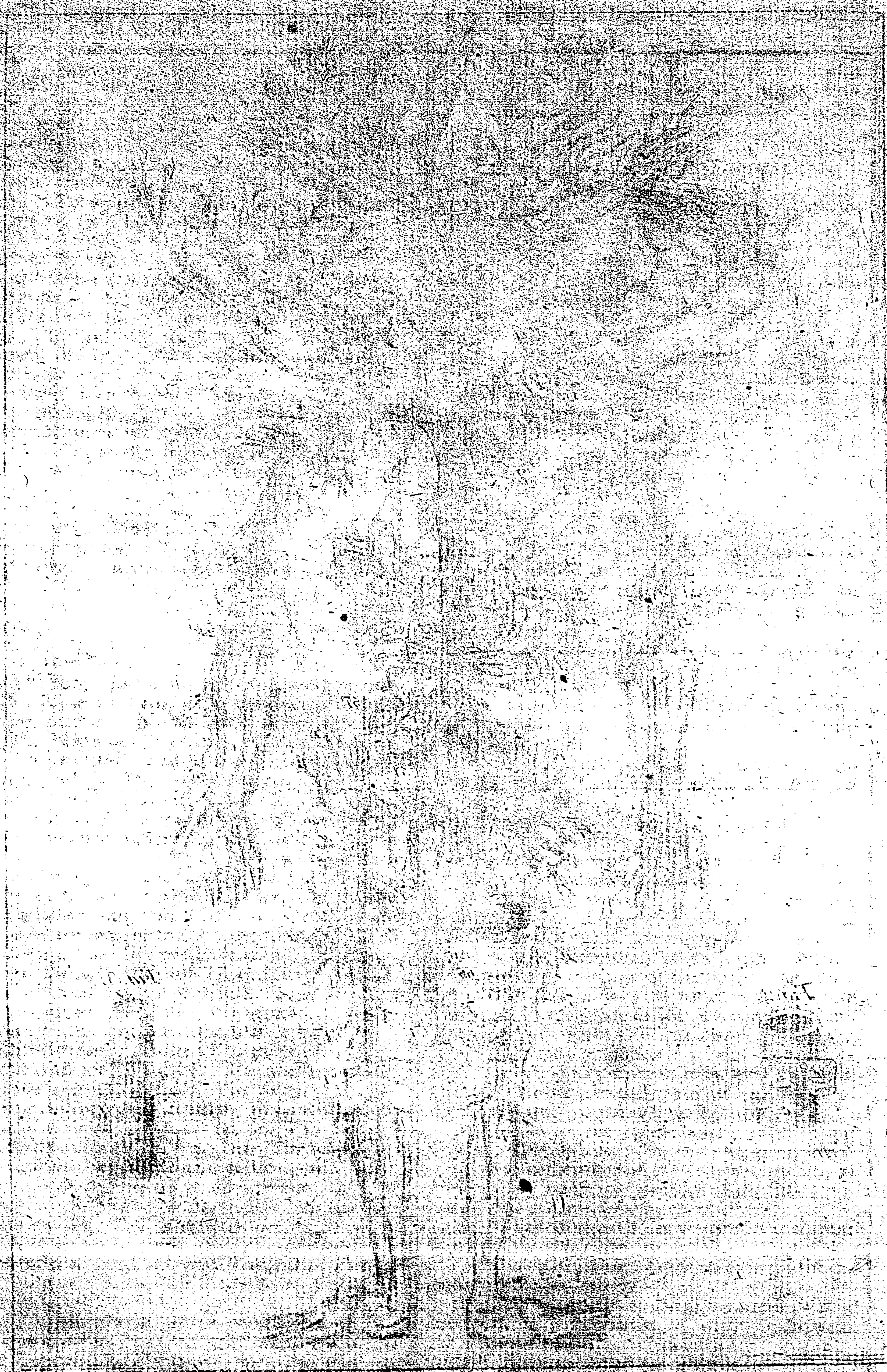


Fig. 3.





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# BRAIN.

Fig. 1.

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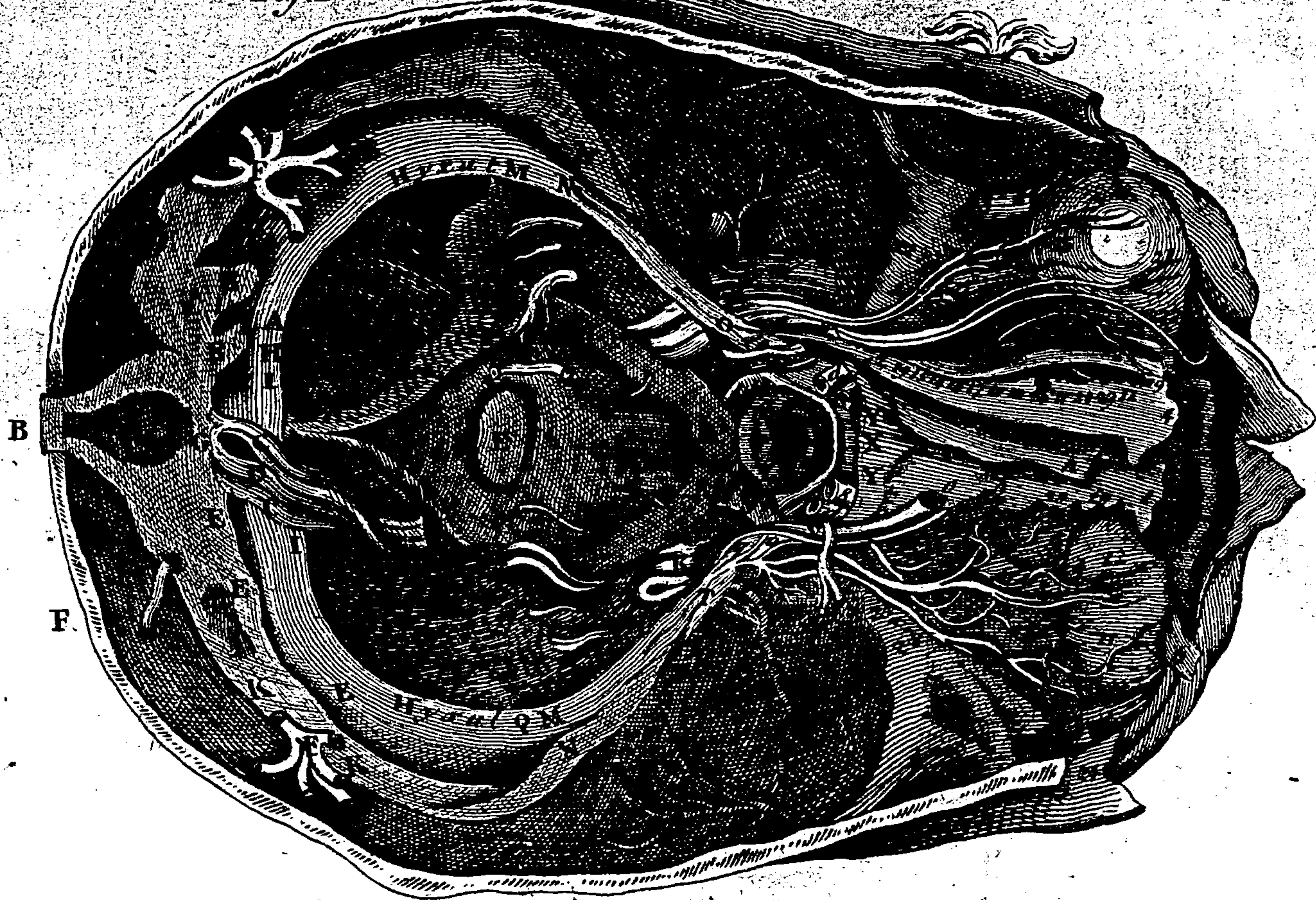
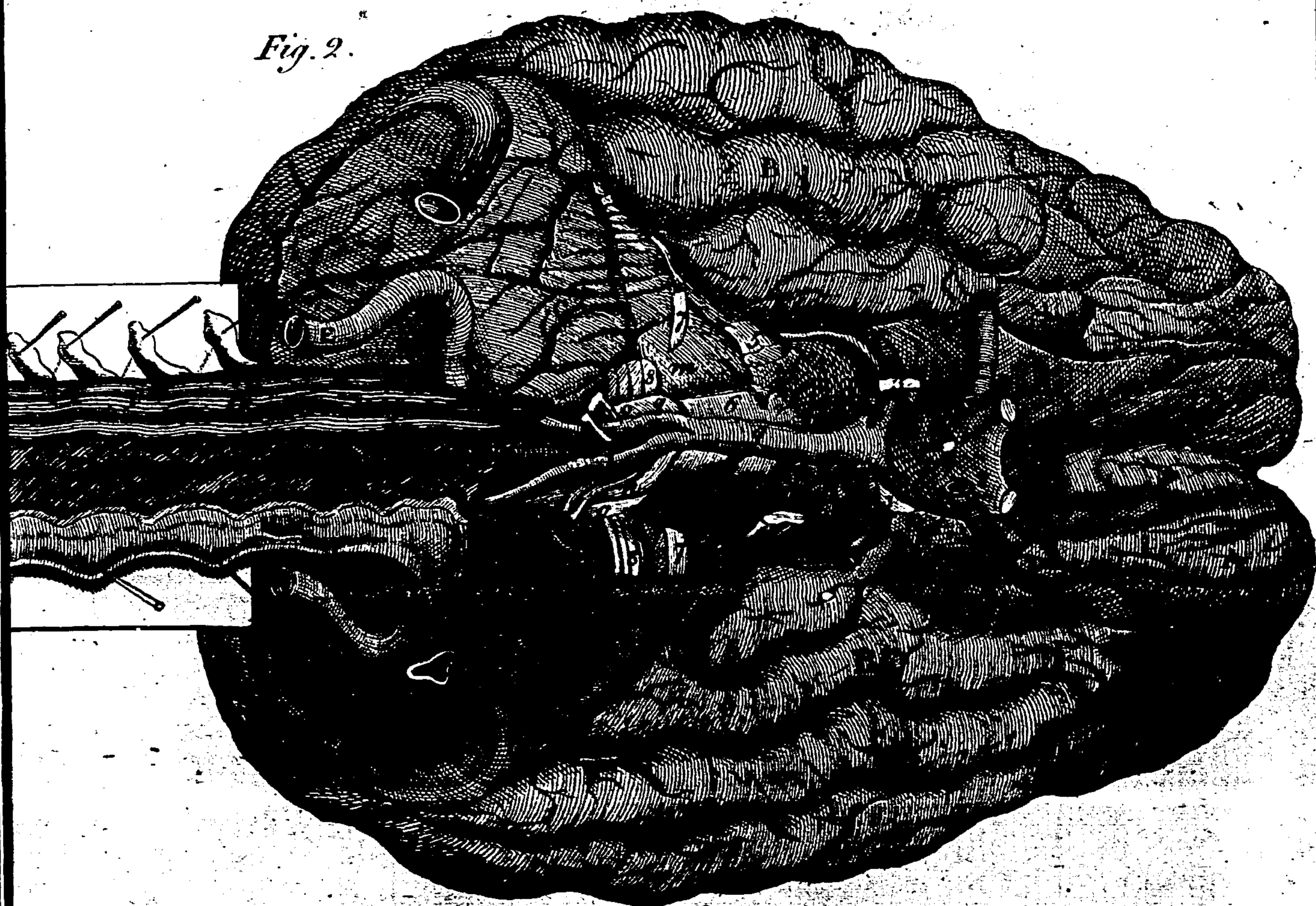


Fig. 2.

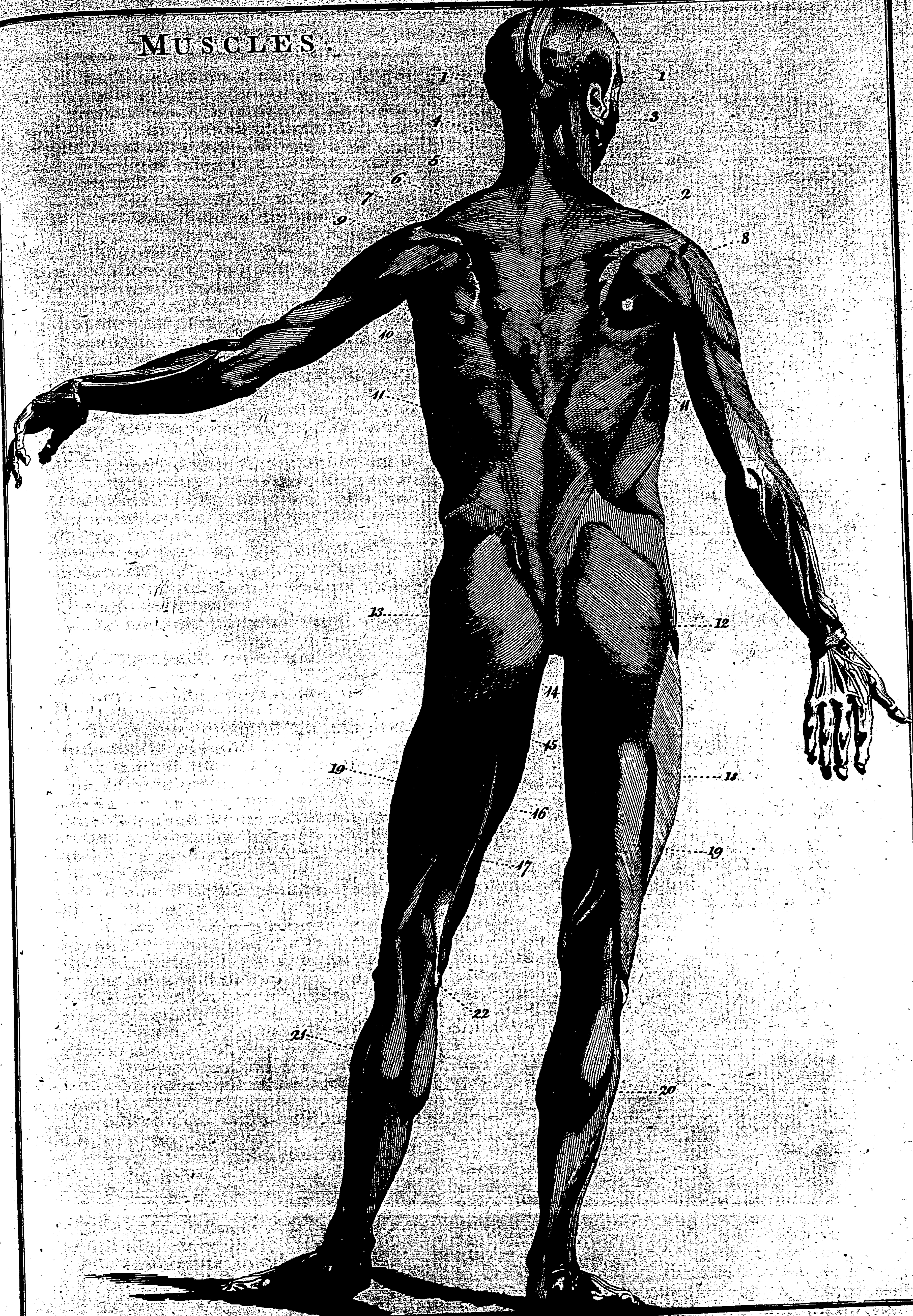






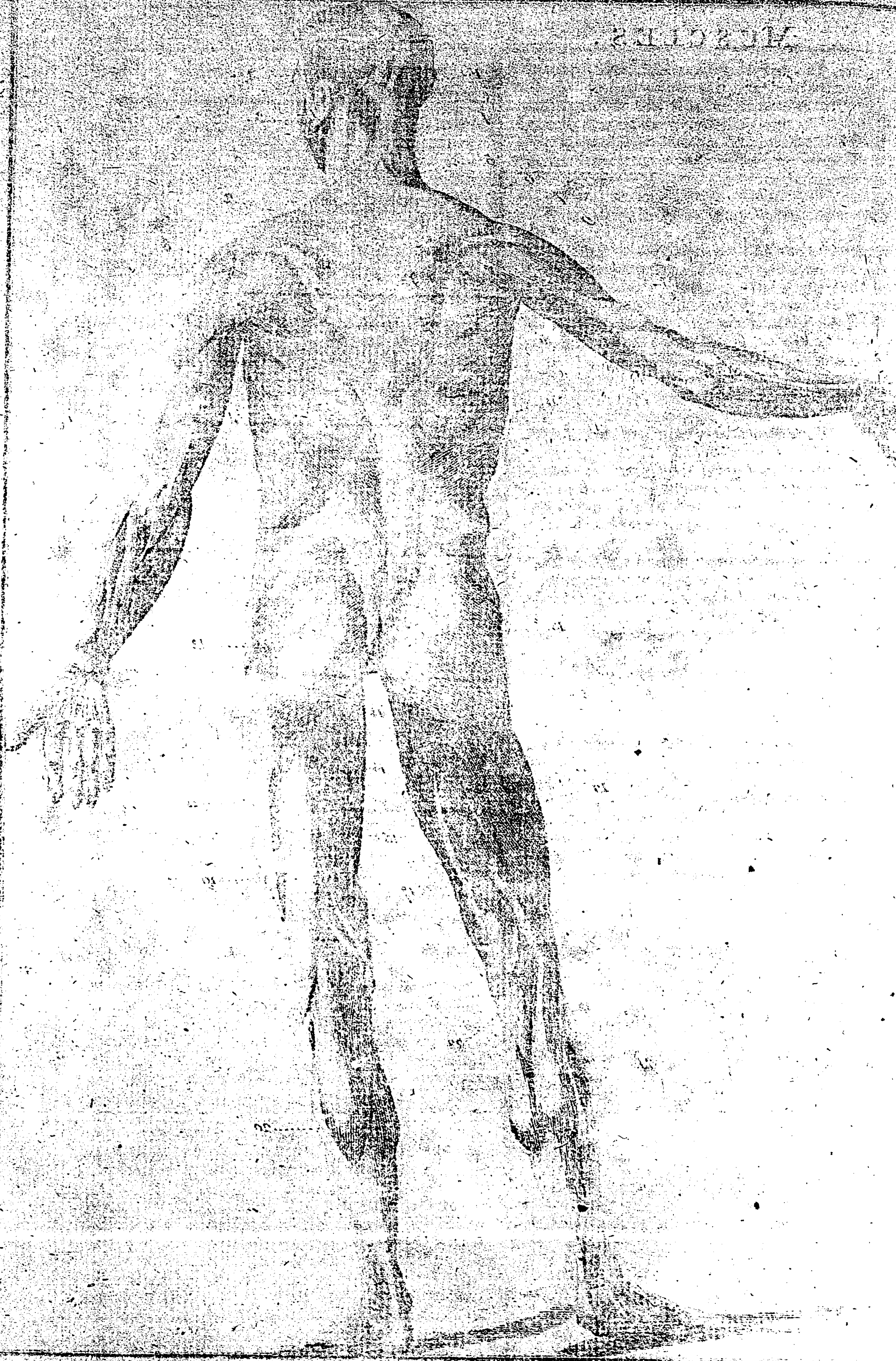


# MUSCLES.





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21. 21. The mammariæ, which arise from the subclavian arteries, and descend to the cartilages of the true ribs internally, on each side the os pectoris or sternum. Some branches of these pass through the pectoral as well as intercostal muscles, and give blood to the breast, where they meet some branches of the intercostal arteries.

22. 22. The arteries of the muscles of the os humeri, and some of those of the scapula.

23. 23. 24. 24. Those parts of the large trunks of the arteries of the arm, which are liable to be wounded in opening the vena basilica, or innermost of the three veins in the bending of the cubit.

25. 25. A communicant branch of an artery arising from the trunk of the artery of the arm, above its flexure at the cubit, which is inosculated with the arteries below the cubit.

26. 26. The external artery of the cubit, which makes the pulse near the carpus.

27. 27. Arteries of the hands and fingers.

28. 28. The descending trunk of the arteria magna.

29. The bronchial artery, springing from one of the intercostal arteries: it sometimes arises immediately from the descending trunk of the aorta; and at other times from the superior intercostal artery which springs from the subclavian.

30. A small artery, springing from the fore parts of the aorta descendens, and passing to the gula.

31. 31. The intercostal arteries on each side the arteria magna descendens.

32. The trunk of the arteria cæliaca, whence spring,

33. 33. The hepatick arteries, and

34. The arteria cystica, or the gall-bladder.

35. Arteria coronaria ventriculi inferior.

36. The pylorica.

37. The epiploica dextra, sinistra, and media, springing from the coronaria.

38. The ramifications of the coronary artery, which embrace the bottom of the stomach.

39. Coronaria ventriculi superior.

40. 40. The phrenick arteries, or the two arteries of the diaphragm; that on the left side arising from the trunk of the arteria magna; the right springing from the cæliaca.

41. The trunk of the splenick artery, arising from the cæliaca, contorted.

42. The two small arteries going to the upper part of the duodenum and pancreas; the rest of the arteries of the pancreas spring from the splenick artery in its passage to the spleen.

43. The trunk of the arteria mesenterica superior turned towards the right side.

44. The branches of the superior mesenterick artery, freed from the small guts. Here the various anastomoses the branches of this artery make in the mesentery, before they arrive at the intestines, may be observed.

45. The inferior mesenterick artery, arising from the arteria magna.

46. Remarkable anastomoses of the mesenterick artery with the superior.

47. 47. The branches of the inferior mesenterick artery, as they pass to the intestinum colon.

48. Those of the rectum.

49. The emulgent arteries of the kidneys.

50. The vertebral arteries of the loins.

51. 51. The spermatick arteries, which descend to the testes, and are so small as to escape being filled with wax.

52. Arteria sacra.

53. Arteriæ iliaci.

54. 54. Rami iliaci externi.

55. 55. Iliaci interni.

56. 56. The two umbilical arteries cut off; that

on the right side is drawn as in the foetus, and the left expressed as in an adult.

57. 57. The epigastrick arteries, which ascend under the right muscles of the abdomen, and are inosculated with the mammariæ.

58. 58. Branches of the external iliac arteries, passing between the two oblique muscles of the abdomen.

59. 59. Branches of the internal iliac arteries, which convey the blood to the extensores and ob-turatores muscles of the thighs.

60. The trunks of the arteries which pass to the penis.

61. 61. The arteries of the bladder.

62. 62. The internal arteries of the pudendum, which, with those here expressed with the penis, make the hypogastrick arteries in women.

63. The penis extended with wax, and dried.

64. The glans penis.

65. The upper part of the dorsum penis, cut from the body of the penis, and raised, to shew the corpora cavernosa penis.

66. Corpora cavernosa penis, freed from the ossa pubis, and tied after inflation.

67. The two arteries of the penis, as they appear injected with wax.

68. The capsula and septum of the corpora cavernosa penis.

69. The crural arteries.

70. 70. The arteries which pass to the muscles of the thighs and tibiae.

71. That part of the crural artery that passes the ham.

72. The three large trunks of the arteries of the legs.

73. The arteries of the foot, with their communicating branch, from their superior to their inferior trunk, as well as their communications at the extremity of each toe, like those of the fingers.

#### *Explanation of the Plate of the Brain.*

*Fig. 1.* Is an interior view of the cerebrum and cerebellum.

A, The transverse septum or tent of the cerebellum. B, the longitudinal sinus of the dura mater, which is divided into two branches at its posterior extremity. C, the right sinus divided into two parts, one of which communicates with the right lateral sinus, and the other with the left. D, vestiges of the falx of the brain. E, E, the large veins of the septum A. F, the insertion of the veins of the cerebrum into the lateral sinus. G, the orifice of the posterior occipital sinus. H, H, the posterior occipital sinuses on the right and left. I, I, the falx of the cerebellum. K, K, the great transverse sinus. L, L, the jugular fossæ. M, M, the sinus petrosi inferior. N, N, the sinus petrosi superior. O, O, the veins of the cerebellum which open into the above sinuses. P, P, the inferior occipital sinuses. Q, Q, the canal by which they discharge themselves, and which joins the ninth pair. R, R, the anterior and superior occipital sinuses. S, S, the communication between the sinus cavernosus and circularis. T, the orifice of the sinus petrosus superior, by which it communicates with the sinus cavernosus. V, V, sinus cavernosi. X, X, the transverse sinus of the pituitary fossa. Y, Y, the circular sinus of Ridley. Z, Z, the insertion of the anterior veins of the cerebrum into the sinus cavernosi. a, a, the principal artery of the dura mater. b, b, the vein which accompanies it. c, the part of the cranium which it there enters by a particular foramen. d, d, the internal carotid arteries in the sinus cavernosus cut off at the place where they enter the cerebrum. e, e, the arterial branches sent to the sinus



of the nerve of the fifth pair. *f, f*, part of the internal carotid produced to the ophthalmick artery. *g, g*, the posterior apophyses clinoides. *h*, the apophysis, called crista galli. *i, i*, the frontal sinuses. *k, k*, branches of the fifth pair, distributed on the dura mater. *l*, the fourth branch of the fifth pair. *m*, the second branch. *n*, the first of ophthalmick branch. *o*, the third part. *q*, the partition which divides the fifth and sixth pair. *r*, the sixth pair. *s*, origin of the intercostal nerve. *t, t*, entrance of the seventh pair into the dura mater. *u, u*, first insertions of the eighth pair. *x, x*, second insertions of the eighth pair. *y, y*, the ninth pair. *z*, the foramen of the medulla spinalis.

*In the right Eye, the superior Part of the Orbit taken off.*

*1, 1*, The ophthalmick artery. *2, 2*, its exterior branch, which accompanies the nerve of the same name. *3, 3*, the interior branch distributed to the nostrils. *4, 4*, the sclerotick branches, several of which are distributed to the uvea. *5, 5*, vestiges of the levator muscles of the eye-lid and of the eye. *6*, the extremity of the levator of the eye-lid. *7*, the lacrymal gland. *8*, the optick nerve. *20, 21, 22, 23, 24, 25, 26, 27, 28, 29*, the same as in the eye of the opposite side.

*In the left Eye.*

*9*, The annular cartilage. *10*, the great oblique muscle. *11*, the levator of the eye. *12*, the abductor or internal muscle of the eye. *13*, the abductor cut off. *14*, the superior branch of the third pair, distributed to the eye and eyelid. *15*, the other part of the trunk. *16*, branch to the nerve to the obliquus inferior. *17*, branch to the right inferior of the eye. *18*, branch to the right internal. *19*, branch to the ophthalmick ganglion. *20*, superior branch of the first branch of the fifth pair. *21*, the exterior rope of that branch. *22*, interior rope. *23*, exterior branch of the first branch of the fifth pair. *24*, small branches extended to the face, through the foramina of the ossa malarum. *25*, branches to the lacrymal gland. *26*, inferior branches of the second branch of the fifth pair. *27*, rope of that branch to the ganglion. *28*, small filaments to the nostrils. *30*, the ophthalmick ganglion. *31*, the small ciliary nerves. *7, 8*, the same as in the right eye.

*Fig. 2. Exhibits the basis of the brain, with part of the medulla oblongata, the blood vessels being injected with wax.*

*A, A*, the fore lobes of the brain. *B, B*, the hinder lobes. *C, C*, the cerebellum. *D, D*, the lateral sinuses. *E, E*, the vertebral arteries, as they pass between the first vertebra and the bone of the occiput. *F*, the vertebral sinus.

*G, G, G, G, G*, the dura mater on the right side taken off from the spinal marrow, and remaining on the left.

*1, 2, 3, 4, &c.* the ten pair of nerves belonging to the brain, with seven of the spinal marrow.

*a*, the foramen that opens into the pituitary gland from the infundibulum.

*b, b*, the two white protuberances behind the infundibulum.

*c, c*, the two trunks of the carotid artery cut off where they began to run betwixt the fore and hinder lobes of the brain.

*d, d*, the two arteries joining the carotids, with the cervical artery called the communicant branches.

*e, e*, two large branches of the cervical artery, sometimes seeming as though they came from the communicant branch on each side, from the first of which the plexus choroides hath its original in chief, and from the last the plexus choroides of the fourth ventricle.

*f*, several little branches arising from the carotid artery.

*g*, the cervical artery composed of the two trunks of the vertebral artery within the cranium.

*h, h*, the two trunks of the vertebral artery.

*i, i, i*, the spinal artery.

*k*, a small branch of an artery running through the ninth pair.

*l, l*, the crura of the medulla oblongata.

*m, m*, the annular protuberance, or pons varolii.

*n*, that part of the caudex medullaris on the right side, called, by Willis and Vieussenius, corpora pyramidalia.

*o*, that part on the same side called corpus olivare.

*p*, the foremost branch of the carotid artery, dividing the fore lobes of the brain, consisting of two branches, one of them only appearing here.

*q, q*, little branches of arteries helping to make the plexus choroides in the fourth ventricle.

*r, r, r, r*, branches of arteries dispersed from the cervical artery upon and through the annular protuberance.

*s, s*, part of the second process or pedunculi of the cerebellum.

*t, t*, the spinal accessory nerve.



## Illustration of the BOTANICAL PLATES.

**I**N our INTRODUCTION to the Natural History of VEGETABLES, page 296, we observed, that the immense labours, which some late botanists have undergone, to give a list of the names of plants, can contribute little to the discovery of their properties. We should be led to suppose, from the repeated endeavours to systematise this science, that the whole of the student's pursuit was directed to acquire the names of plants. More time has been consumed in making catalogues of this nature, than, if properly applied, would have been sufficient to have enabled the botanist to discover several new properties in the vegetable world, as yet unknown.

For these reasons, the botanical systems of flowers, plants, leaves, mosses, and cups of flowers, were, intentionally, omitted: however, in order to gratify the taste of curious speculators, and that of the learned, we shall here treat the above subjects agreeable to systematical arrangements; particularly those adopted by LYNNÆUS and TOURNEFORT; wherein the several Orders and Genera of flowers and plants will be considered; and for a particular account of the various characters, and Latin appellations, we refer our readers to the numerous plates, under the general head of Botany.

### BOTANY.

**T**HE term Botany, says a modern writer, has been understood as expressing the doctrine of plants at large, and in all its various lights; but tracing the origin and progress of the study, we see it at several periods under distinct appearances. These, however, are all reducible to those general heads, which we may distinguish by the terms philosophic, historical, and systematic Botany. Of these the first and noblest has been the least cultivated; it began, and in a manner ended, with Theophrastus; its object is the nature of vegetables as vegetables, independent of all other considerations; to this succeeded the historical branch, gathering the names and numbers of plants, their places of growth, their virtues, and other æconomic uses: this was the object of those, who studied herbs, from Theophrastus to the latter end of the sixteenth century, when Cæsalpinus gave origin to the systematic Botany: till this time plants were arranged, even those who wrote best on them, according to the old and irregular division, into trees, shrubs, and herbs; or according to their virtues, the letters of the alphabet, which began with their names, or by such vague and arbitrary methods. Their increased number now made it necessary they should be better arranged: and this great author has struck out that path, which has since been trod so happily, of examining their parts and deducing thence the characters of classes, arranging in each class all those, which had the peculiar mark which made its distinction. The origin of systematical distribution was the selecting some part of a plant, which was obvious and regular in itself, and establishing a character upon its description, to which all others that had the same mark were referred. Thus were formed the characters of classes first, and then the distinc-

tive mark of the genera. Between these there came naturally some lesser peculiarity, the subdivision of the classes by orders. The original invention was the choice of some one part of the character, and what part that should be was left to discretion. The great inventor chose the seeds, which he arranged according to the situation of the corculum, or heart of the seed, and to its place upon the plant; and upon this basis he founded the first arrangement of plants. Afterwards various parts of plants, and various collections of parts were adopted for the characters of classes. One hundred and three years after Cæsalpinus, Morrison a Briton, entered successfully into the same path; Ray followed, Knoutius followed Ray, and Herman followed him. Riverius was cotemporary with Knoutius; these both wrote in the year 1690, and after four years more followed Tournefort, the greatest of them all. Thus closed upon the science the seventeenth century, in the last seventeen years of which the long neglected institution of Cæsalpinus was so well revived, that there appeared no less than six distinct systems of plants, and each of very considerable merit. The authors of the four first held the fruits and seed, according to the original practice of Cæsalpinus, to be the properest, at least the most essential parts, on which to found a system. Riverius struck out the design of fixing the characters in the flower, and Tournefort pursued this with the greatest attention, industry and truth. Boerhaave, who wrote in the beginning of the 18th century, continued the system in its original course, making the fruits and seeds of plants his great object in their arrangement. In 1711, Henscher of Wirtemberg appeared with credit, and led a long train; who less regarding the original object of distinction, followed Riverius and Tournefort in the choice of the flower. Seven years after, Ruppilus wrote, adopting the same part as the foundation of his system, and thus continued the established doctrine with Pontedera, Hebenstret, and Hudwig. In the mean time Magnal distinguished himself by a new system, formed upon the construction of the cup; and in the year 1735 Linnæus, too great for praise, published that system of Botany, which characterizes the classes according to the parts of generation or fructification, the filaments, and style; and takes into the general distinction all the flower.

### FLOWERS.

**T**HOUGH no part of plants is more different than their flowers, yet the definitions given by different authors of the word are extremely various, and are very necessary to be explained, in order to the understanding their works. Jungius defines it to be the most tender part of a plant, remarkable for its colour or form, or for both, and cohering with the fruit. Yet this author himself acknowledges his definition to be too confined, as he very well knew there were several plants, whose flowers were produced remote from the fruit.

Mr. Ray says, the flower coheres for the most part with the rudiments of the fruit, but such phraseology is by no means to be admitted into definitions.



definitions. Tournefort defines it to be a part of a plant very often remarkable for its peculiar colours, for the most part adhering to the young fruit, to which it seems to afford the first nourishment, in order to explicate its most tender parts; but this is a more indeterminate definition than the former, from its loose mode of expression. Pontedera defines it to be a part of a plant, unlike the rest in form and nature. If the flower has a tube, it adheres to, or is fixed very near to the embryo, to the use of which it is subservient; but if the flower has no tube, then its base does not adhere to the embryo. This is scarce intelligible except to the expert botanist, and may be made to take in some parts of plants by no means to be understood by the name of flowers. Jussieu defines it to be composed of chives and a pistillum, and to be of use in the generation of the plant; but this is too imperfect, as there are many plants in which the pistillum is found at a great distance from the chives, and many flowers which have no pistillum, and many others which have no chives.

Valliant, however, has been happier in his definition; he says, that flowers are the organs which constitute the different sexes of plants, which are sometimes found naked and without any covering; and that the petals, which most of them have, are no way essential to their use, but serve and are intended merely as covers for them; but as these coats or coverings are the most conspicuous, and most beautiful part of the flower, these are to be called flowers, be they of whatever form or structure, or colour; and whether they contain only the organs of both sexes in each individual, or only of one, or even but of some part of one, provided that they are not of the same figure and colour with the leaves of the plant. The shortest and most express definition, however, seems to be Martyn's; which is, that flowers are the organs of generation of both sexes, adhering to a common placenta, together with their common covering, or of either sex separately with its proper coverings, if it have any. The structure of the different flowers are very various; but Dr. Grew has observed, that the far greater number of them have the impalement, the foliation, and the attire of chives, &c. Mr. Ray accounts that every perfect flower has the petals, stamina or chives, apices or summits, and the style or pistil, and such as want any of these parts he calls imperfect flowers. The greater number of plants have a flower-cup which is of a firmer structure than their leaves, and serves for their support. The parts of a flower are the ovary or pistil, the corolla or flower-petals, the stamina or chives, the impalement or calyx, and the perianthium, pericarpium, and fruit.

#### *Explanation of the Terms used in BOTANY.*

**PISTIL**, *Pistillum*, denotes the female organ of generation in flowers, and is defined, by Linnæus, as an entrail of the plant, designed for the reception of the farina, or male-dust, wherewith it becomes impregnated; it consists of three parts, viz. the germen, style, and stigma; the germen is the rudiment of the fruit, accompanying the flower, and is of various shapes, but always situated below the style, or stigma, and contains the embryo seeds; the style is the part that serves to elevate the stigma from the germen, and is also of different forms; the stigma, which is of various shapes likewise, is always placed on the top of the style, or, if that be wanting, on the top of the germen; this part is covered with a moisture, for the breaking of the farina into more minute parts.

**COROLLA** is the most conspicuous part of a flower. It expresses the coloured tender part,

which surrounds the organs of generation. The part it is composed of are called petals; if it consists only of one piece, it is called monopetalous: if more, it is said to be dipetalous, tripetalous; and so on, as it consists of two, three, four, or more parts.

**STAMINA**, the male parts of a flower, or its male organs of generation. Linnæus defines the stamina the entrail of the plant, designed for the preparation of the pollen.

Each stamen consists of two parts. 1. The filament or thread, which serves to elevate the anthera or summit, and at the same time connects it with the flower. 2. The anthera, or summit itself, which contains within it the pollen, and when come to maturity, discharges the same.

The stamina being the male part of the flower, the construction and distribution of the sexual system, is principally founded upon, and regulated by them. Such flowers as want the stamina, are called female flowers: such as have the stamina, but want the pistillum, or female part, male flowers; such as have them both, hermaphrodite flowers; and such as have neither, neuter flowers.

Mr. Tournefort takes the use of the stamina to be, as it were, so many excretory canals for discharging the growing embryo of its redundant juices; and of these excrements of the fruit, he takes that farina, or dust, found in the apices, to be formed. But other writers, as Geoffroy, and Linnæus in particular, assign the stamina a nobler use: these authors, explaining the generation of plants in a manner analogous to that of animals, maintain the use of the stamina to be that of secreting, in their fine capillary canals, a juice, which being collected, hardened, and formed into a farina, or dust, in the tops of the apices, is thence, when the plant arrives at maturity, discharged by the bursting of the apices upon the top of the pistil, whence is a passage for it to descend into the uterus, where being received, it impregnates and fecundifies the plant.

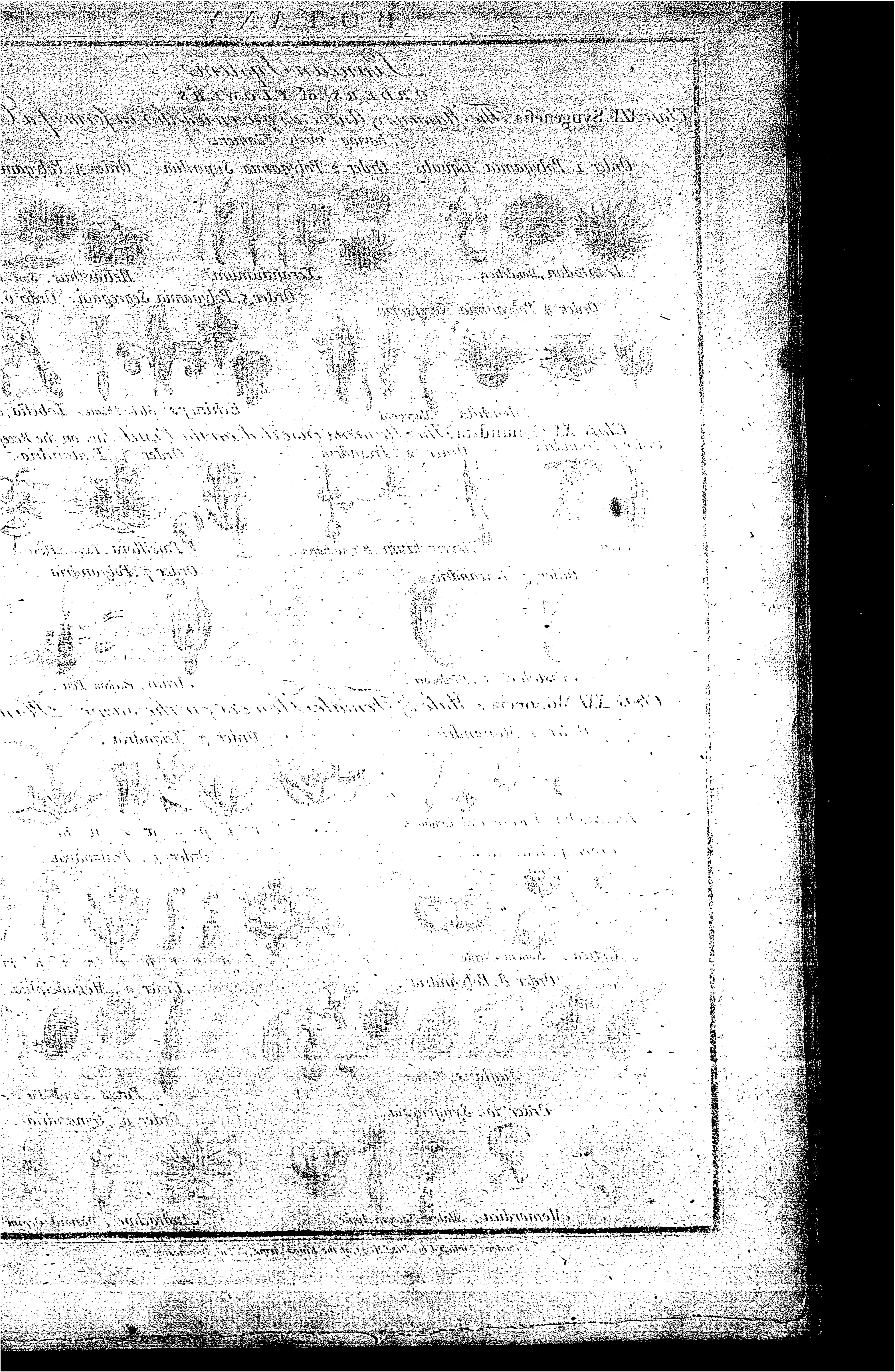
**CALYX**, or *Impalement*, among botanists a general term, expressing the cup of flowers, or that part of a plant which surrounds, incloses, or supports the other parts of the flower. The cups of flowers are very various in their structure, and are distinguished by the names of perianthium, involucre, spathe and gluma. Botanists distinguish two sorts of Calices, one external, called the Calyx of the flower: by the ancients perianthium, as encompassing the flower and seed; the other internal, called the Calyx of the fruit: by the ancients pericarpium, as being the capsule which compasses the fruit, and is itself encompassed by the petals. The external Calyx may also be divided into two sorts, one which surrounds the flower, another which sustains it, different from the pedicle; as the latter spreads itself underneath the flower, to give room for the nutritious juice to raise more freely; the cavity of the pedicle enlarged, is reputed part of the Calyx both external and internal.

**PERIANTHIUM**, a flower-cup situated close to the fructification. It surrounds the lower part of the flower, and consists of several leaves, or of one leaf divided into several segments. If it includes the stamina and not the germen, it is the Perianthium of the flower; if the germen but not the stamina, the Perianthium of the fruit: but if it includes both, it is the Perianthium of the fructification.

**PERICARPIUM**, a covering or case for the seeds of plants; it is the germen of the pistil enlarged: there are no less than nine species of pericarpia. 1. A Capsule. 2. A Conceptaculum. 3. A Pod. 4. A Ligumen. 5. A Nut. 6. A Drupe. 7. An Apple. 8. A Berry. 9. A Strobilus.

THE







## Linnean System

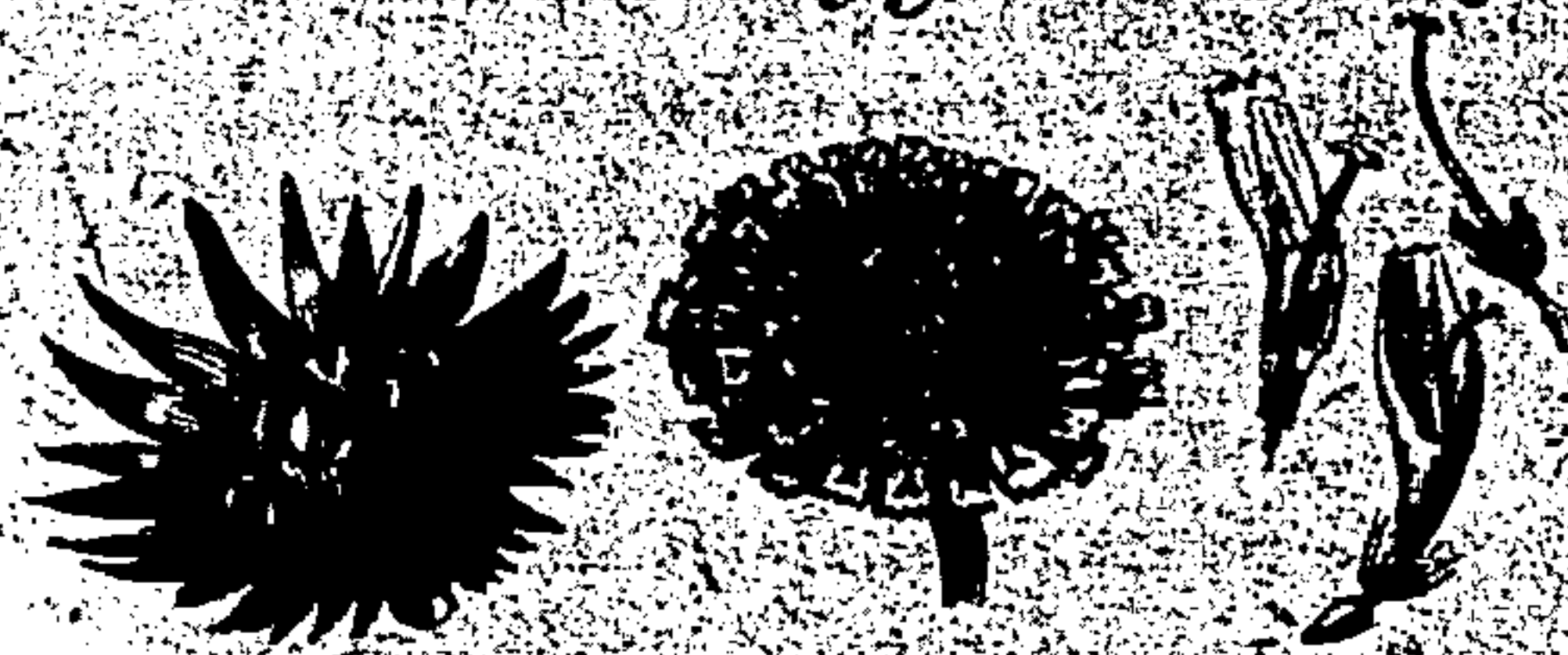
### ORDERS OF FLOWERS.

*Class XIX. Syngenesia. The Stamens & Anthers grown together in form of a Cylinder.  
(having rarely Filaments.)*

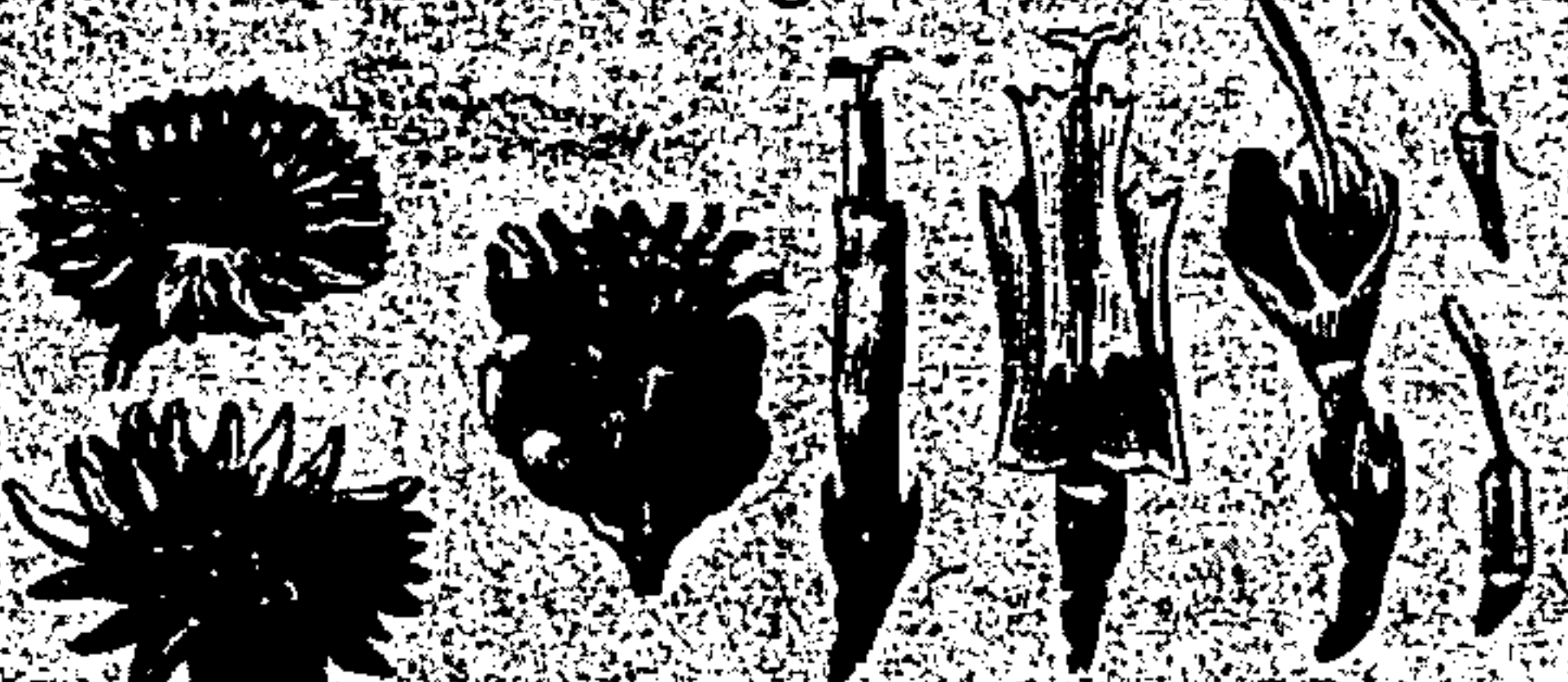
Order 1. *Polygamia Aequalis.*

Order 2. *Polygamia Superflua.*

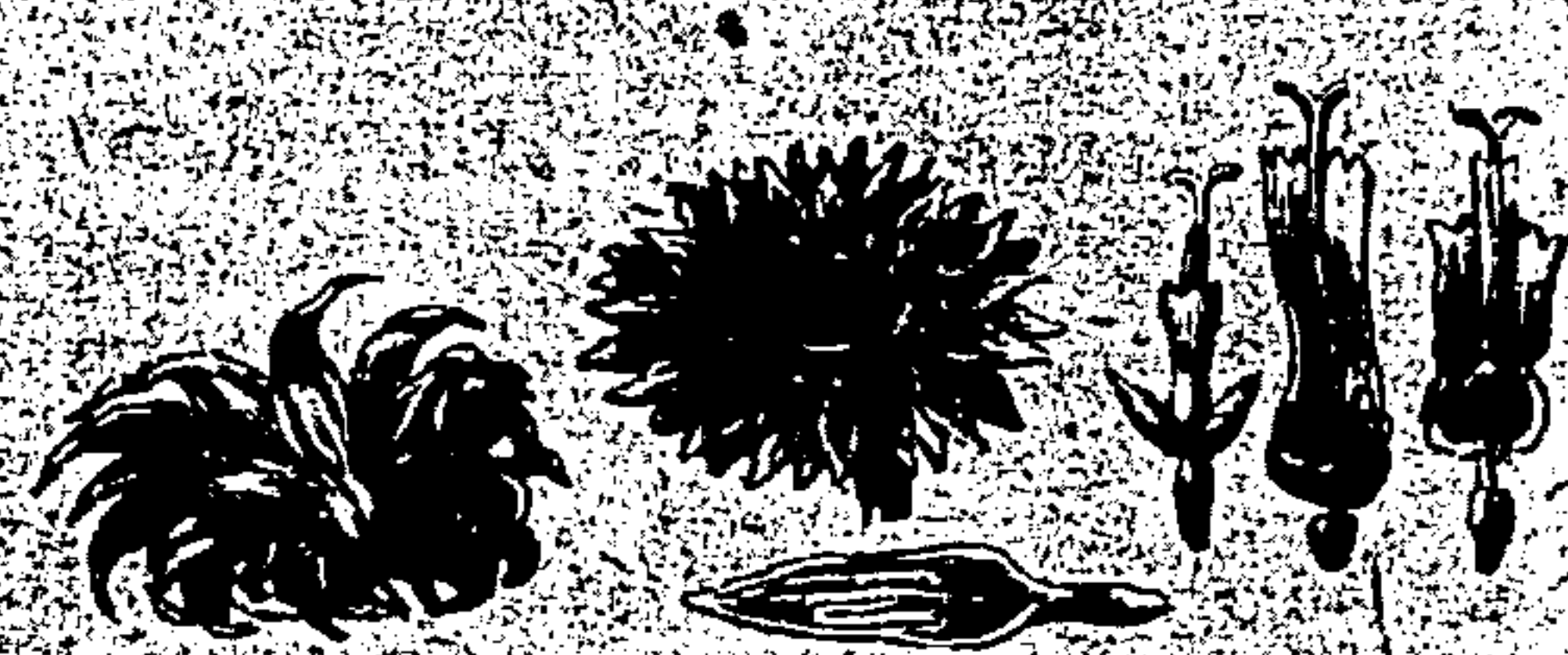
Order 3. *Polygamia Frustanea.*



*Leontodon, Dandelion.*



*Zinnia, Zinnia.*



*Helianthus, Sun-flower.*

Order 4. *Polygamia Neccessaria.*

Order 5. *Polygamia Segregata.*

Order 6. *Monogamia.*



*Calendula, Marygold.*



*Echinops, Globe Thistle. Lobelia, Cardinal Flower.*

*Class XX. Gynandria. The Stamens inserted on the Pistil (not on the Receptacle).*

Order 1. *Diandria.*

Order 2. *Triandria.*

Order 4. *Pentandria.*



*Orchis.*



*Sisyrinchium, Bermudiana.*



*Passiflora, Passion Flower.*

Order 5. *Hexandria.*

Order 7. *Polyandria.*



*Aristolochia, Birthwort.*

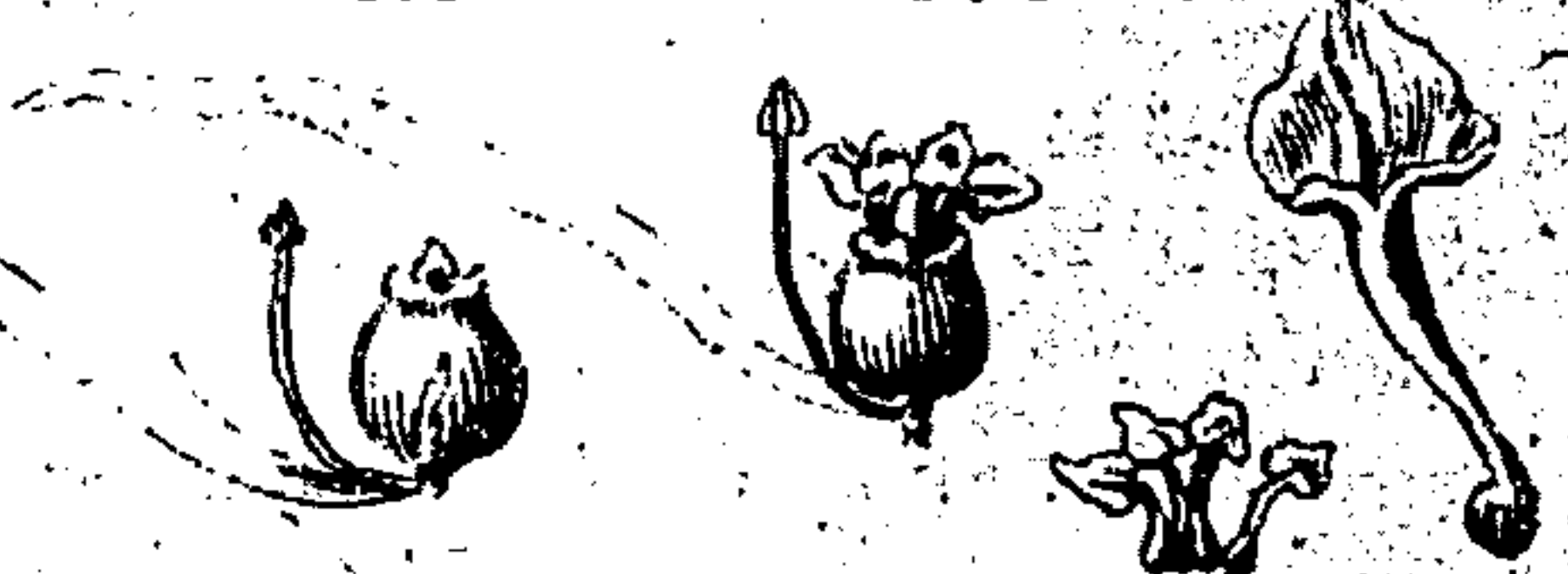


*Arum, Cuckow Pint.*

*Class XXI. Monoecia. Male & Female Flowers on the same Plant.*

Order 1. *Monandria.*

Order 3. *Triandria.*



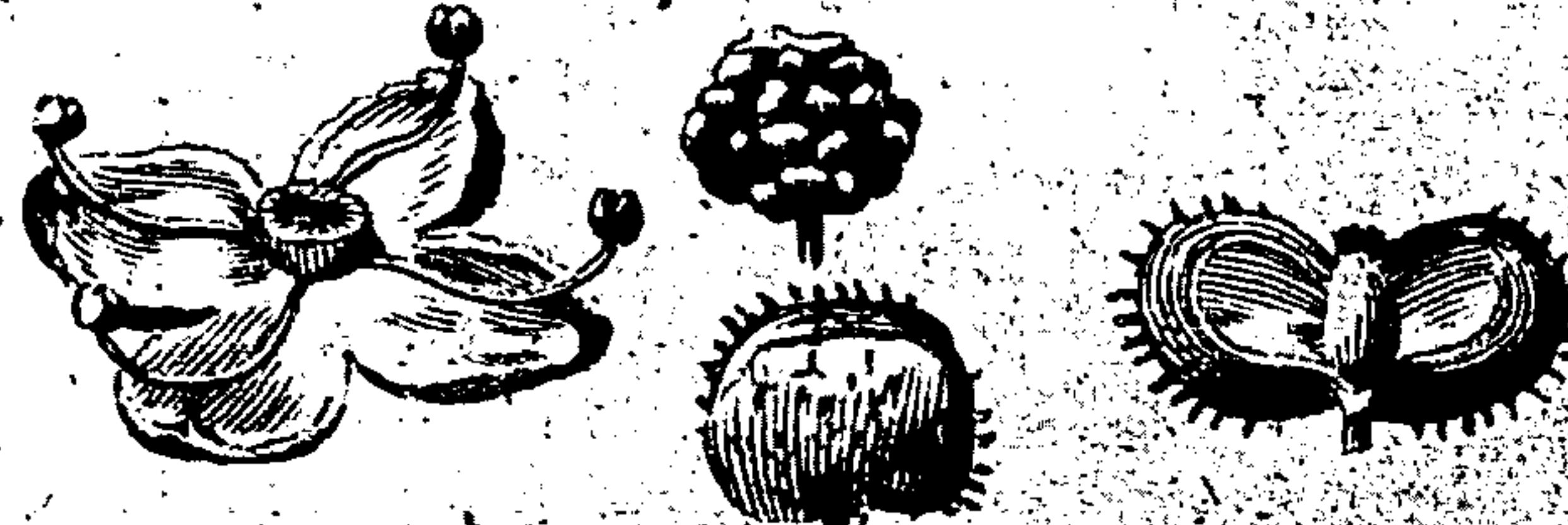
*Zanichellia, Triple-headed Pondweed.*



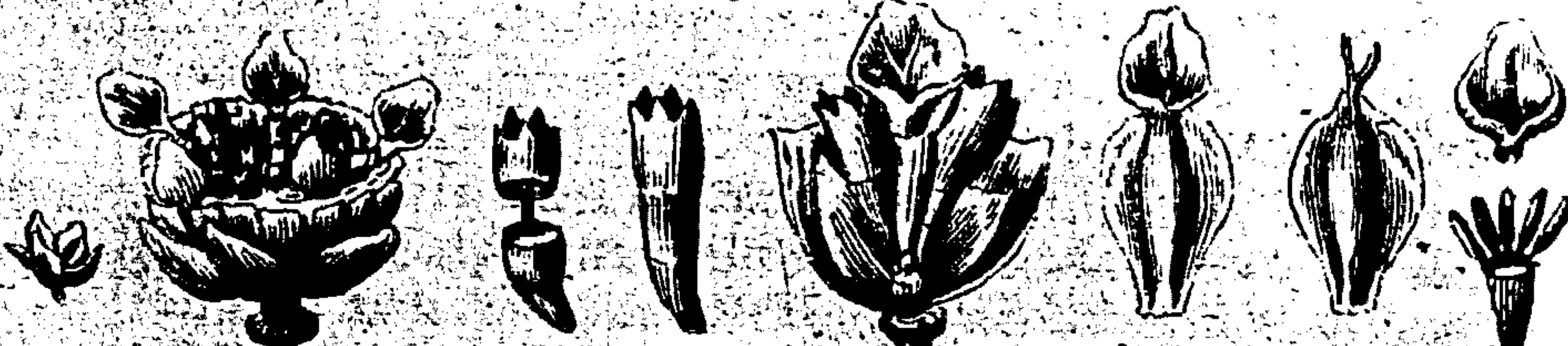
*Tripsacum.*

Order 4. *Tetrandria.*

Order 5. *Pentandria.*



*Urtica, Roman Nettle.*



*Parthenium.*

Order 8. *Polyandria.*

Order 9. *Monadelphica.*



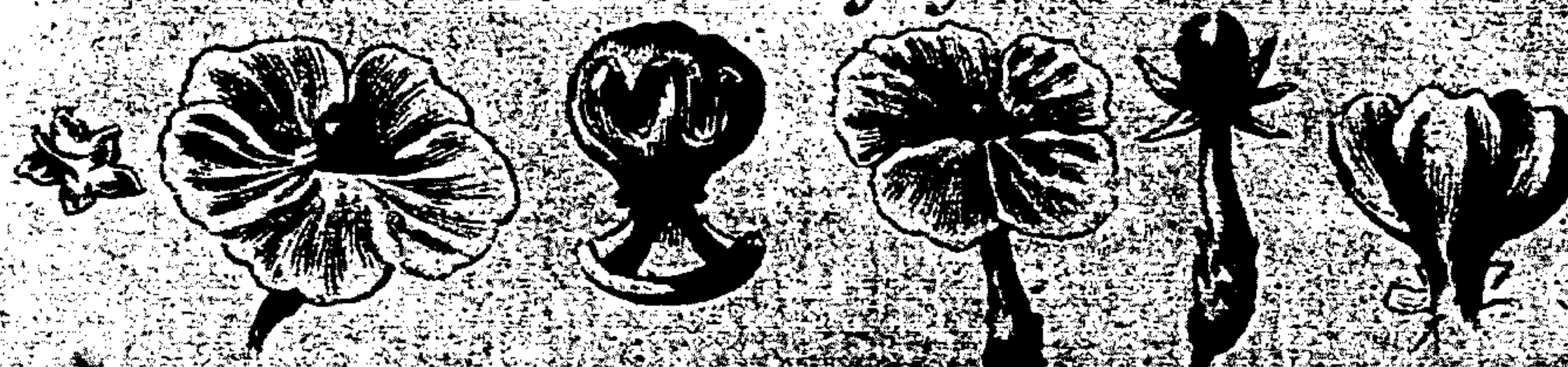
*Juglans, Walnut.*



*Pinus, Scotch Fir.*

Order 10. *Syngenesia.*

Order 11. *Gynandria.*



*Momordica, Male Balsam Apple.*



*Andrachne, Bastard Orpine.*







# Linnean System

## ORDERS of FLOWERS

*Class XIII. Polyandria. The Stamens from Twenty to a Hundred in the same Pistil with the Flower.*

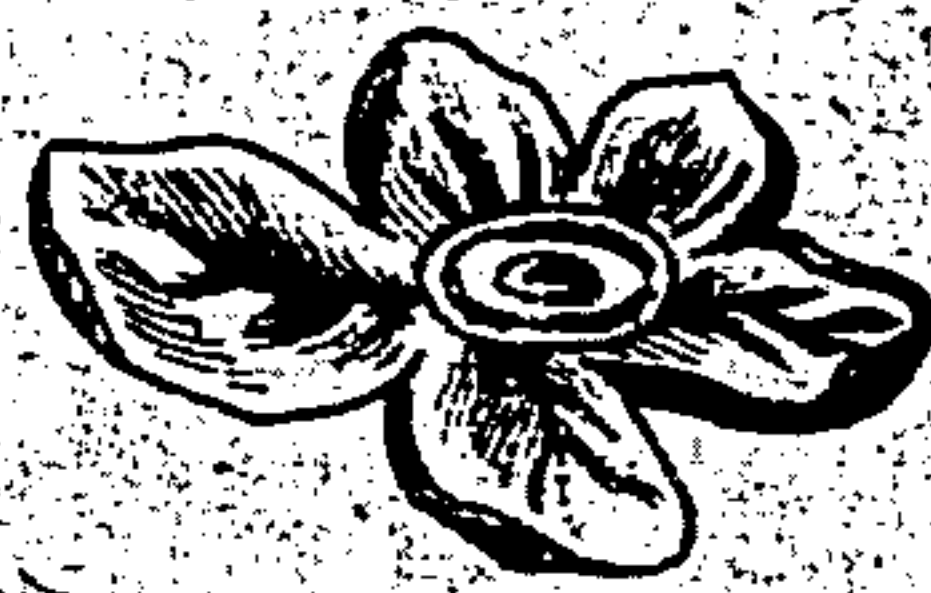
Order 1. Monogynia

Order 2. Dyginia

Order 3. Trigynia



*Sarracenia*



*Pæonia, Piony.*



*Aconitum, Wolfsbane.*

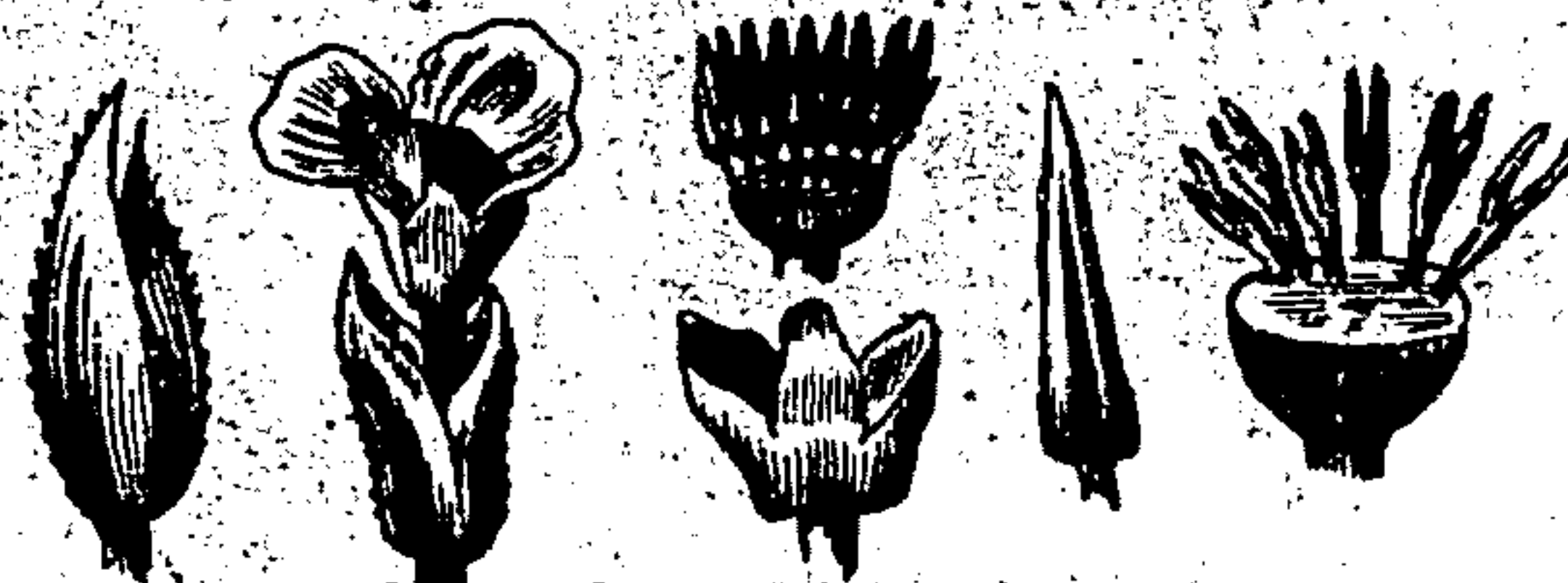
Order 5. Pentagynia

Order 6. Hexagynia

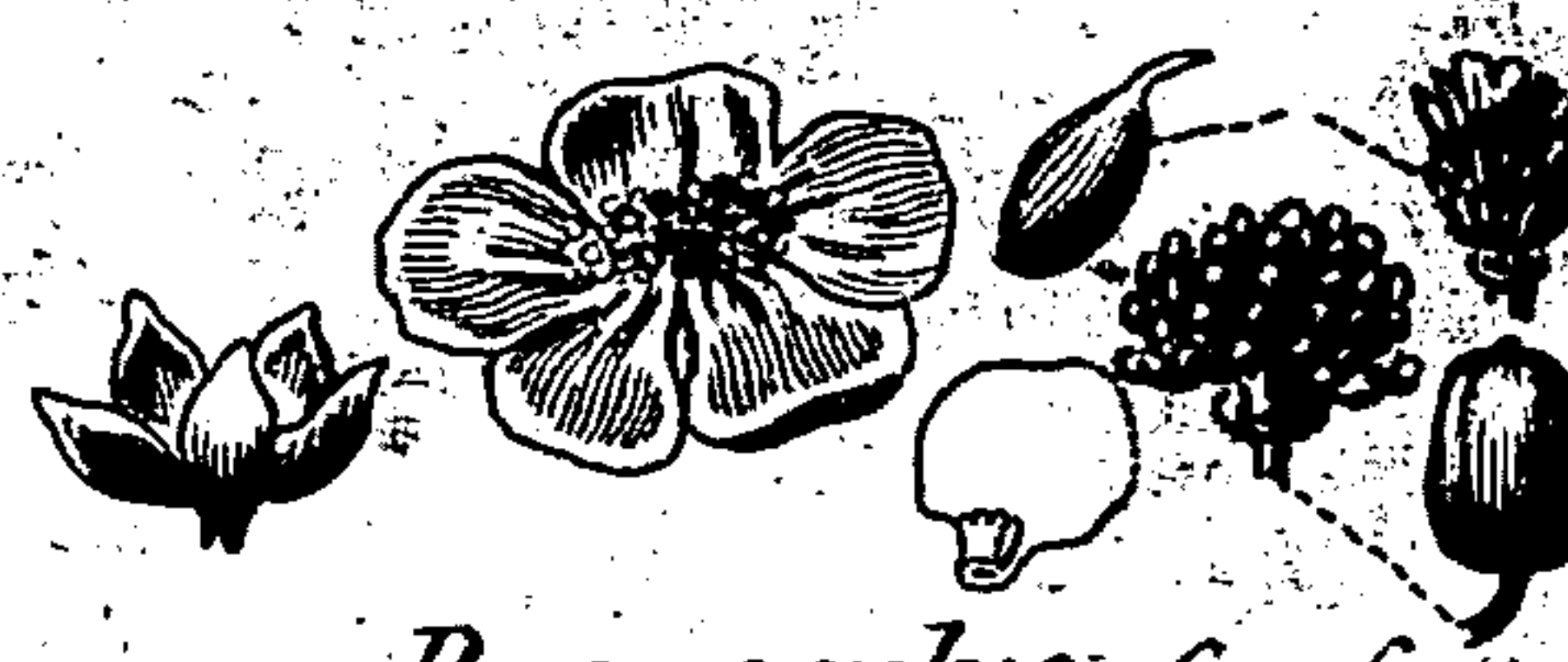
Order 7. Polygynia



*Aquilegia, Columbine.*



*Stratiotes, Water Aloe.*

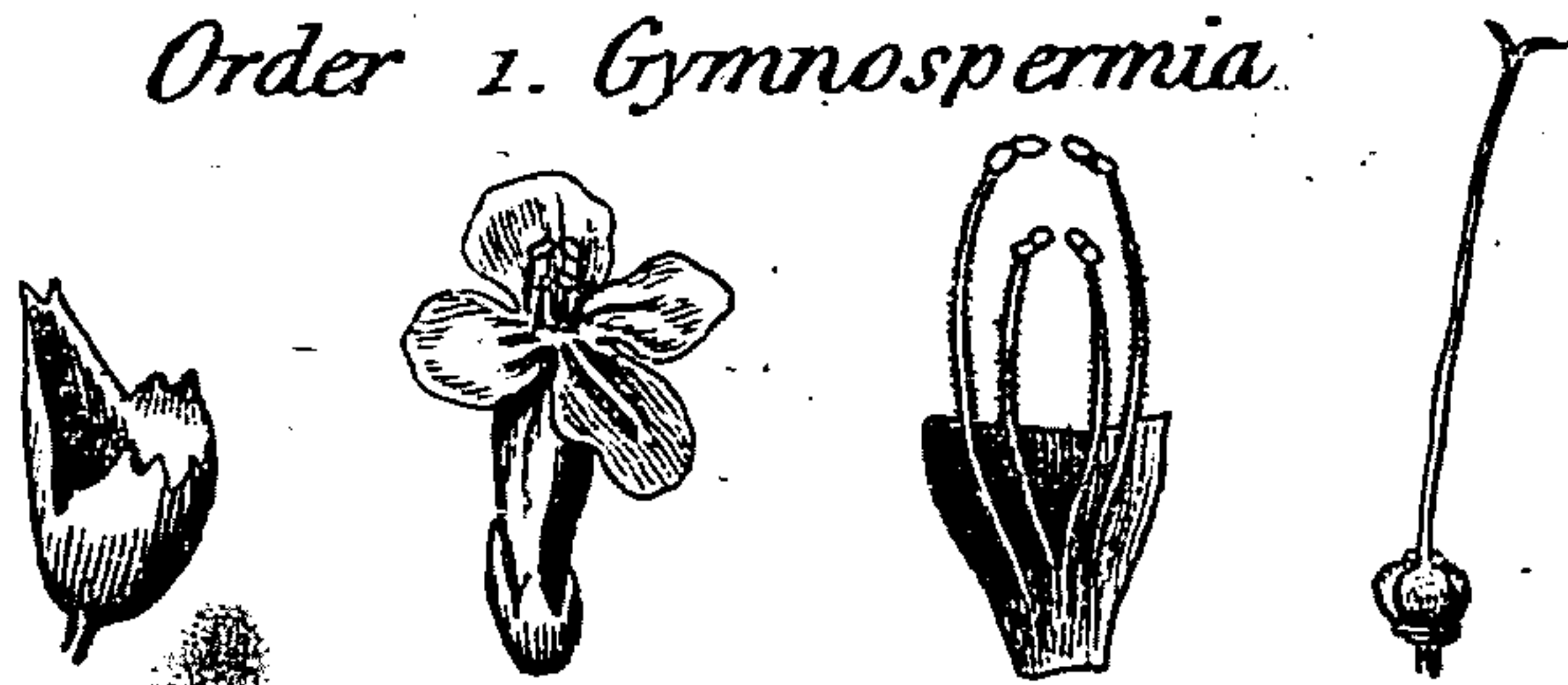


*Ranunculus, Crowfoot.*

*Class XIV. Didynamia. Four Stamens, two are close together and longer*

Order 1. Gymnospermia

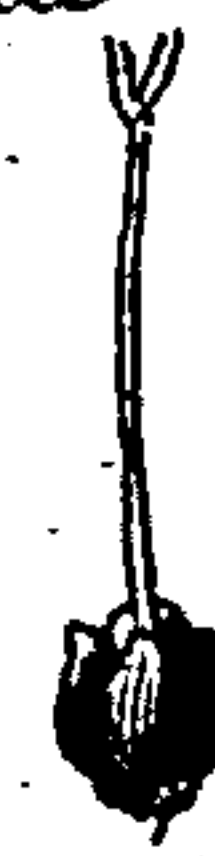
Order 2. Angiospermia



*Melittis*



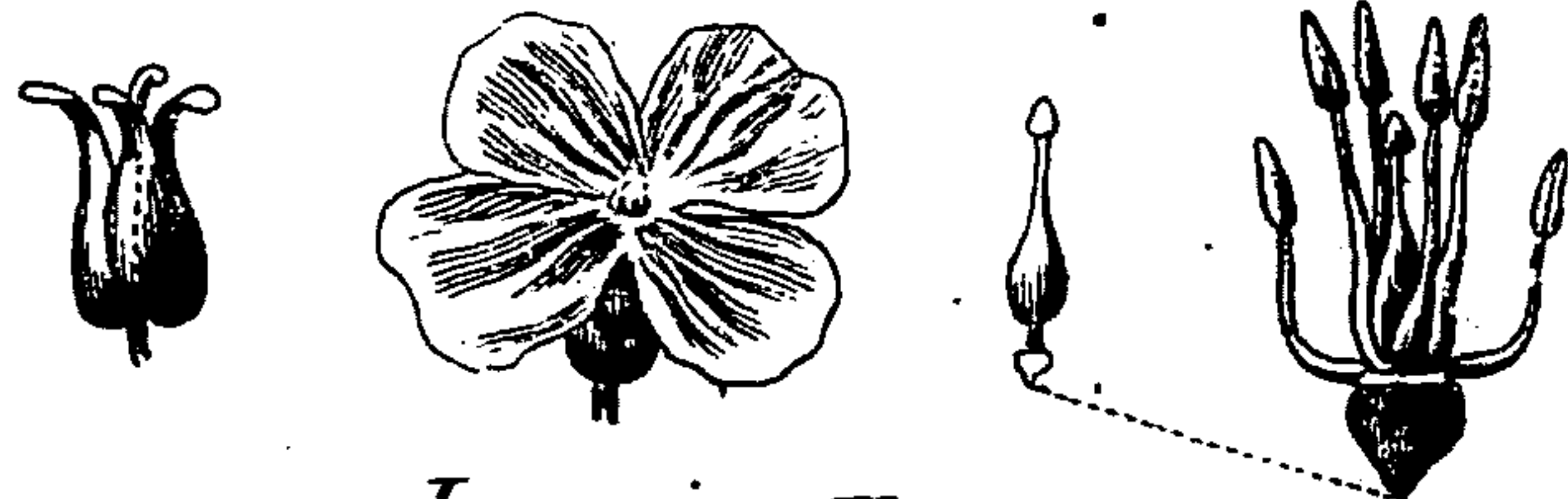
*Melianthus, Honey flower.*



*Class XV. Tetradynamia. Six Stamens, four long, the two opposite short.*

Order 1. Siliculosa

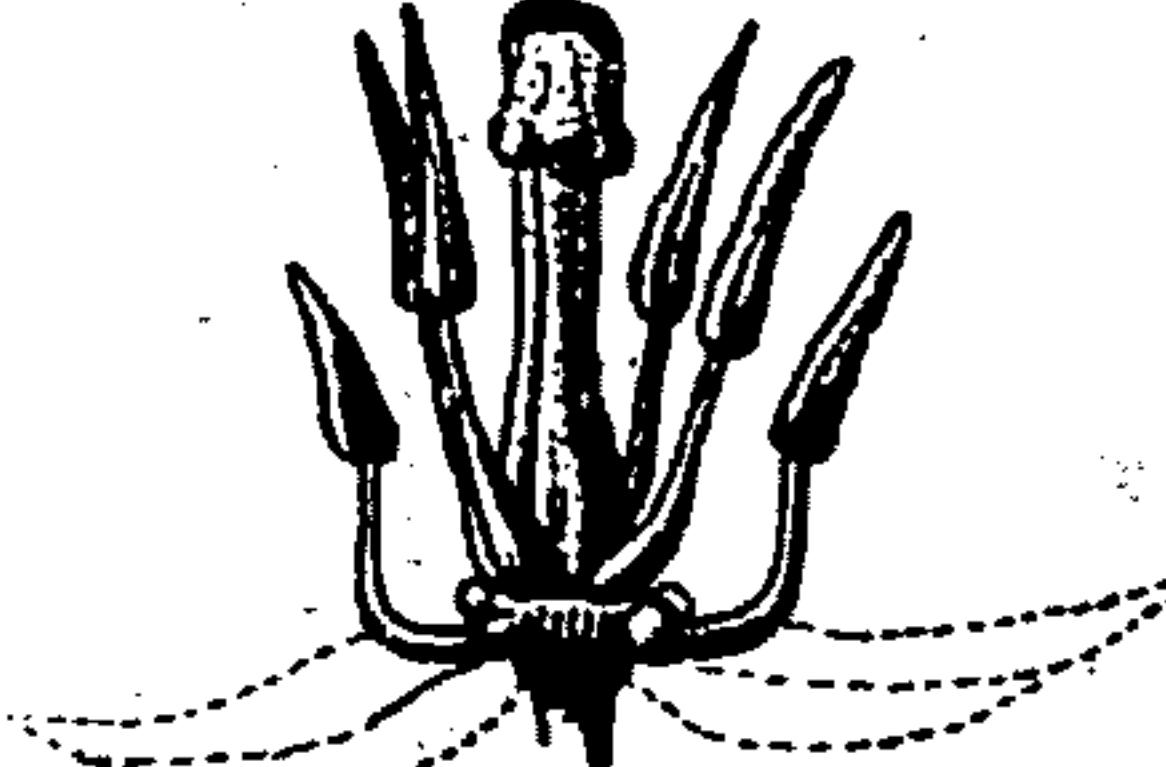
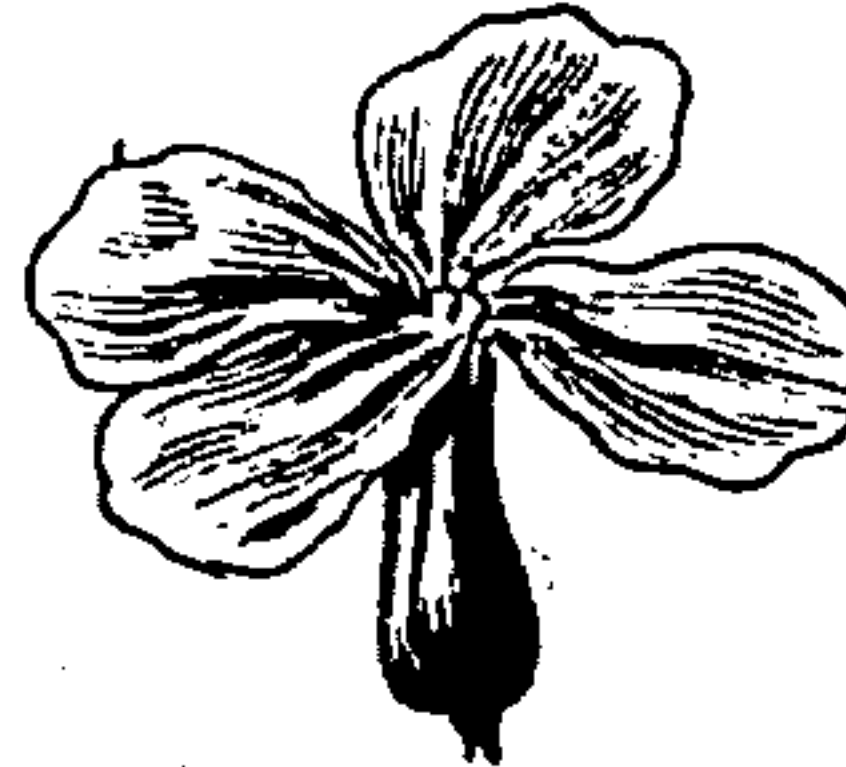
Order 2. Siliquosa



*Lunaria, Honesty.*



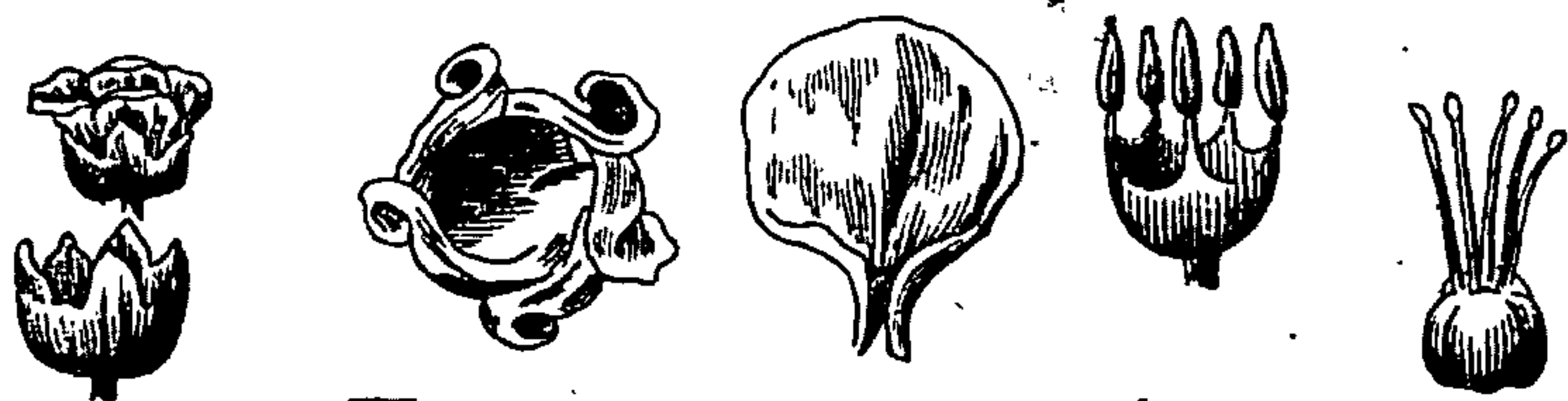
*Cheiranthus, Stock July flower.*



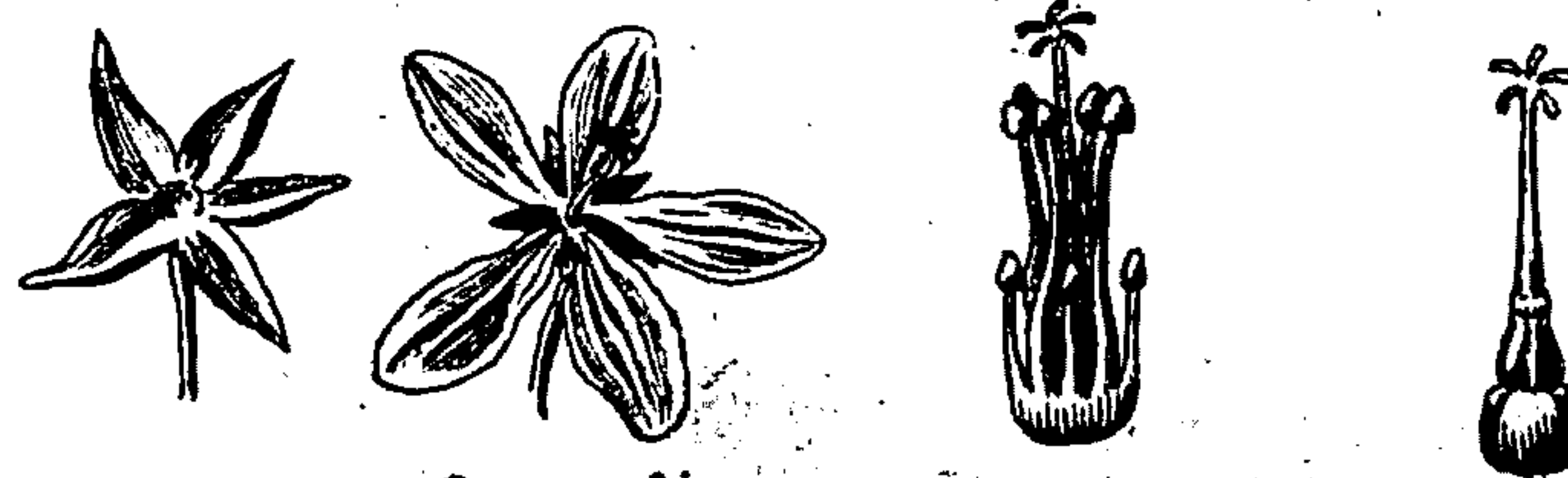
*Class XVI. Monadelphica. The Filaments of the Stamens grown together into one Body.*

Order 1. Pentandria

Order 2. Decandria



*Hermannia*



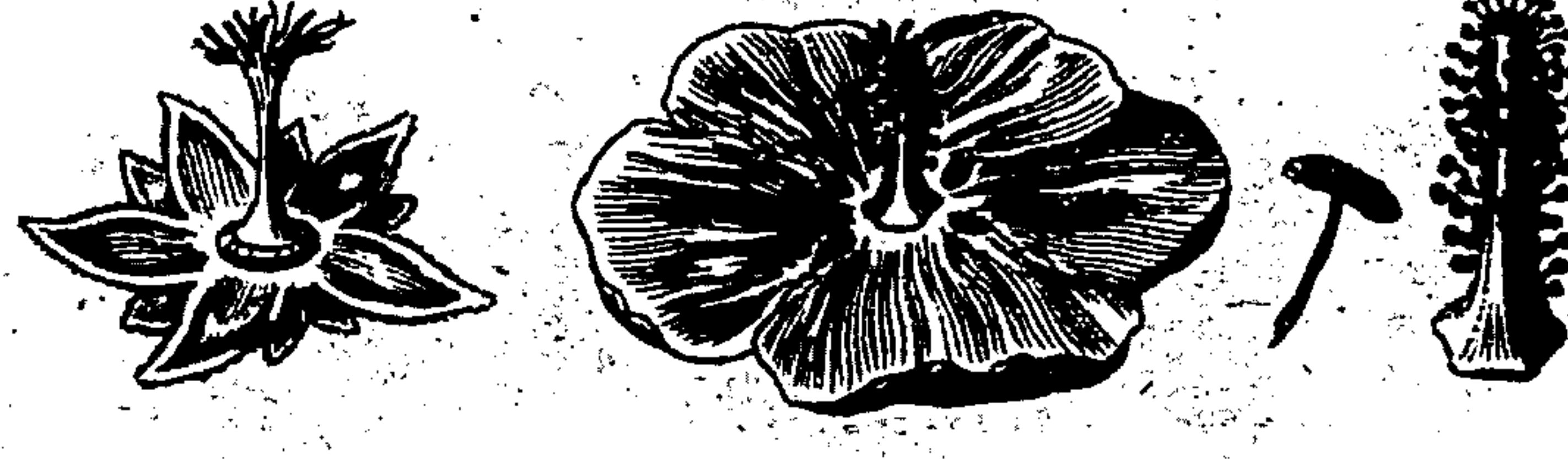
*Geranium, African Cranes-bill.*

Order 4. Dodecandria

Order 5. Polyandria



*Pentapetes, Indian vervain Mallow.*



*Alcea, Rose-Mallow.*

*Class XVII. Diadelphia. The Filaments of the Stamens grown together into two Bodies.*

Order 2. Hexandria

Order 3. Octandria

Order 4. Decandria



*Fumaria, yellow Fumitory.*



*Polygala, Milkwort.*



*Lathyrus, everlasting Pea.*

*Class XVIII. Polyadelphia. The Filaments of the Stamens grown together into 3 or more Bodies.*

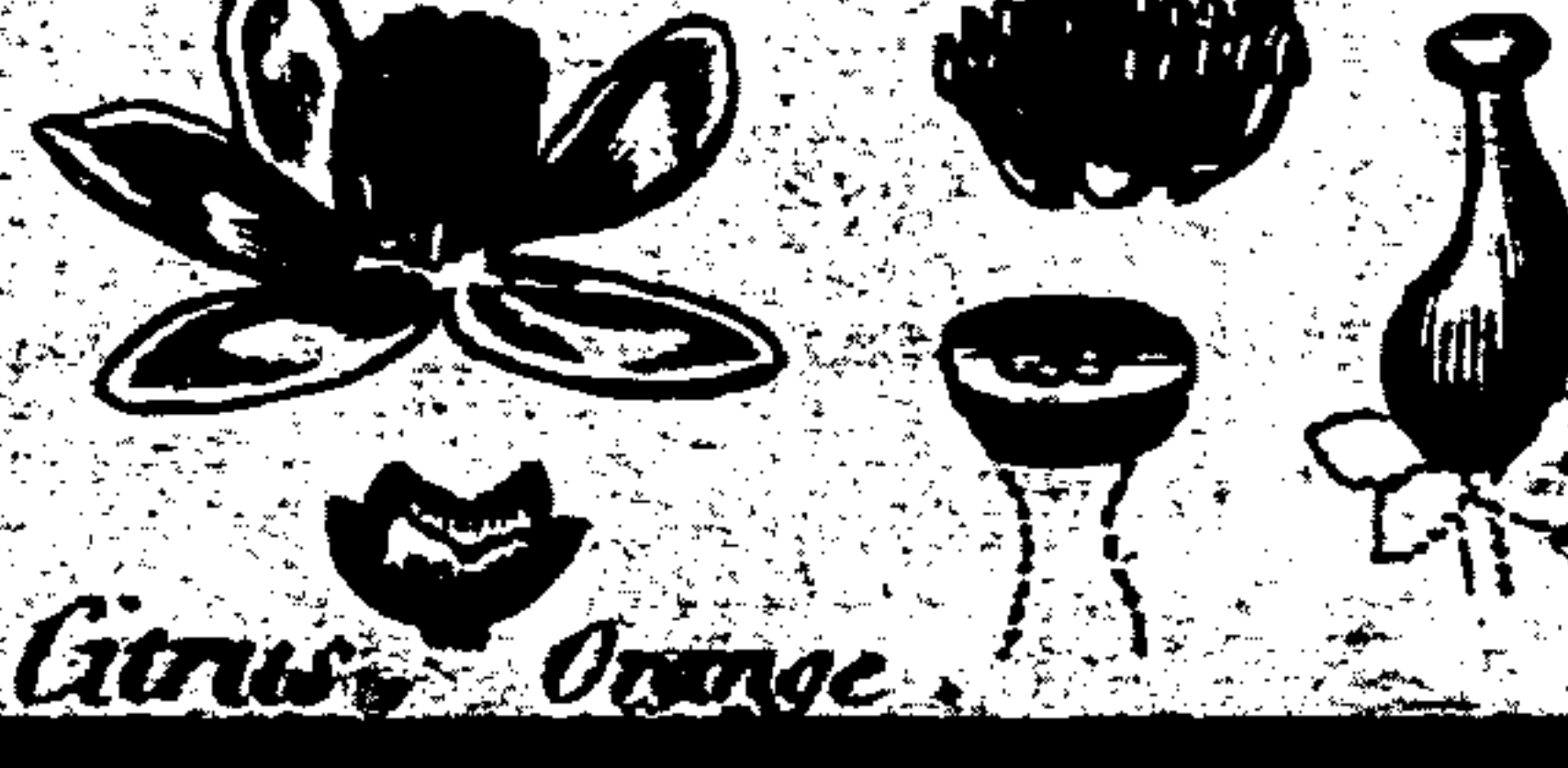
Order 1. Pentandria

Order 2. Icosandria

Order 3. Polyandria



*Theobroma*

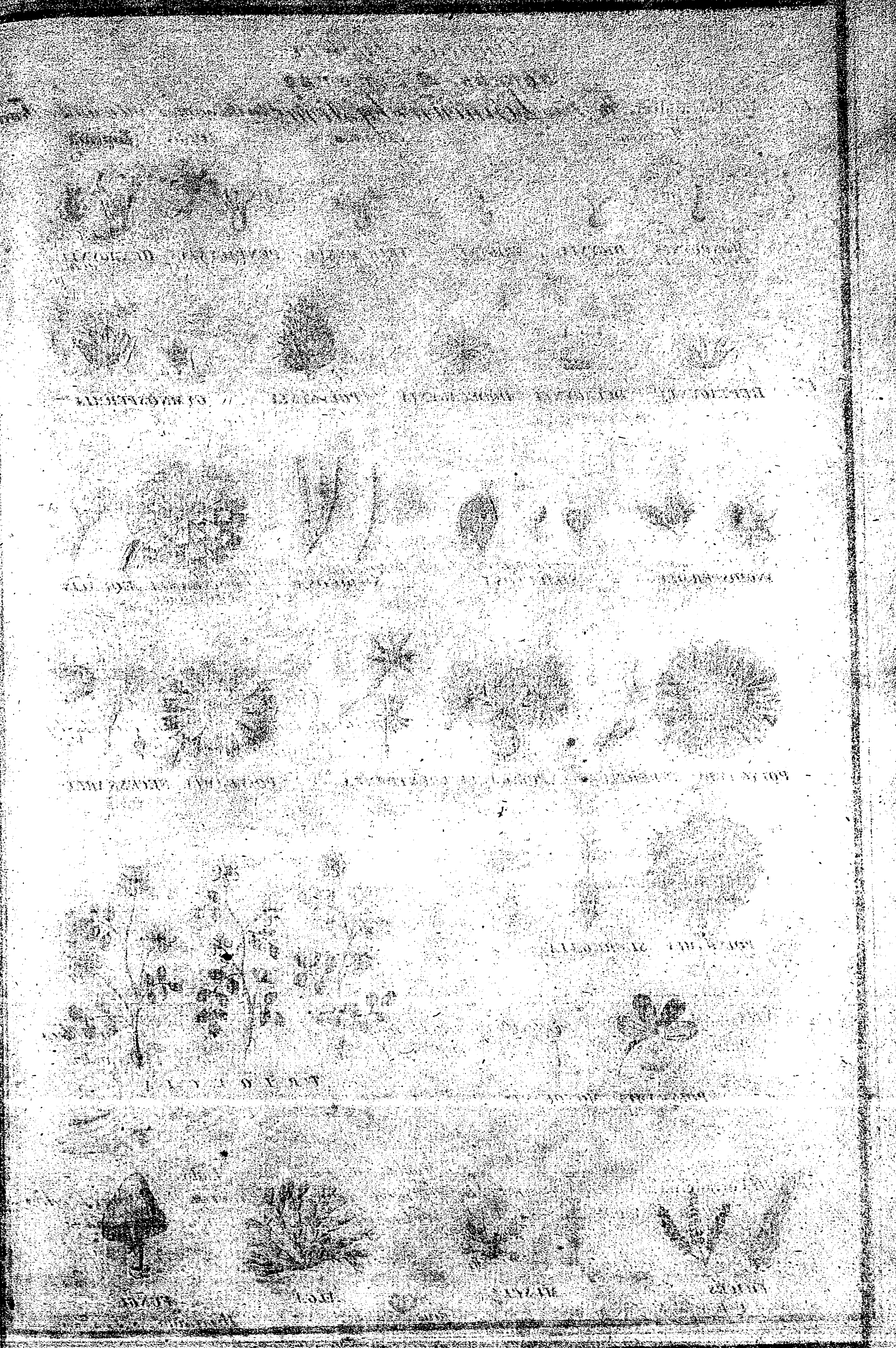


*Citrus, Orange.*



*Hypericum, St. John's-wort.*







# *Linnean System*



MONOGYNIA



DIGYNIA



TRIGYNIA



TETRAGYNIA



PENTAGYNIA



HEXAGYNIA



HEPTAGYNIA



DECAGYNIA



DODECAGYNIA



POLYGYNIA



GYMNOSPERMIA



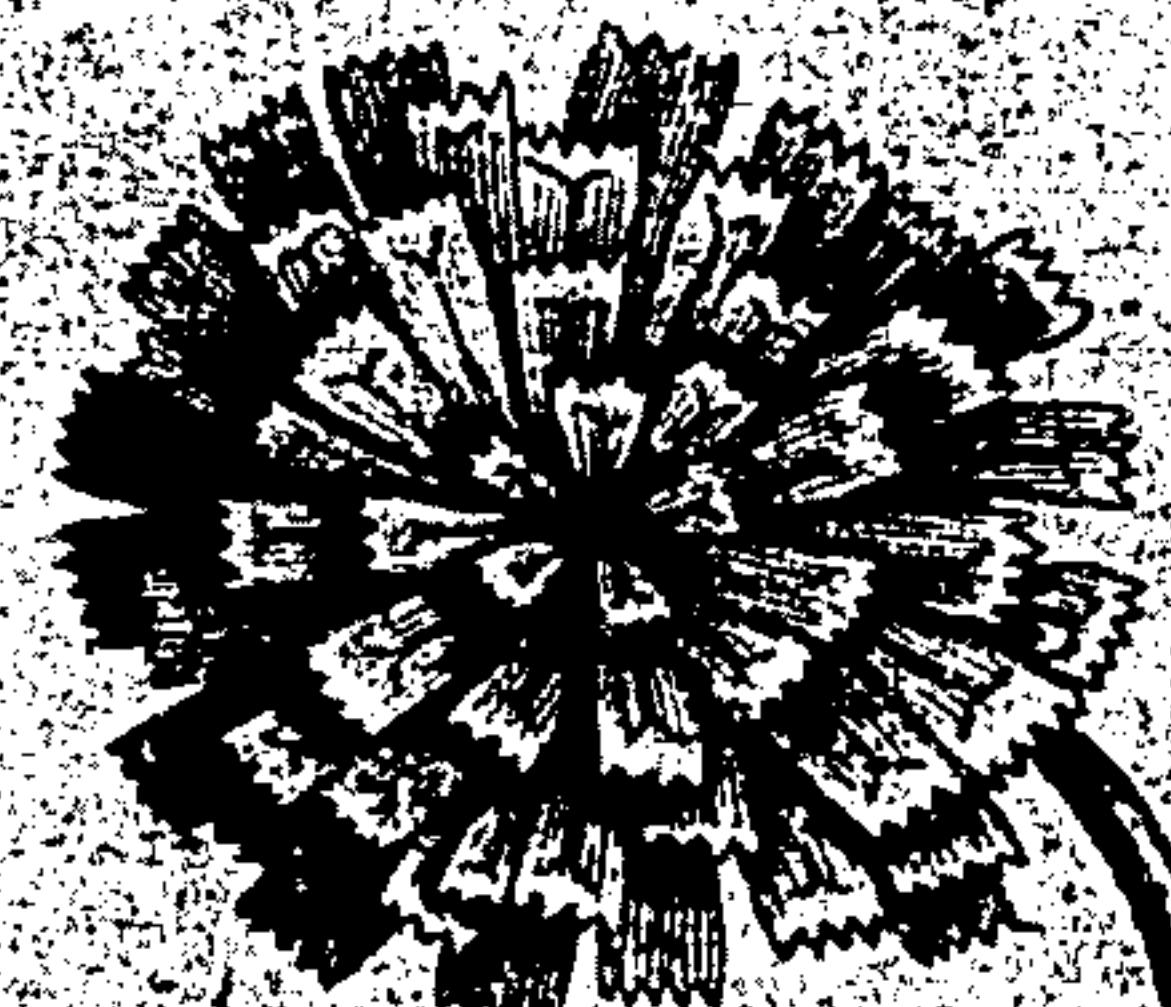
ANGIOSPERMIA



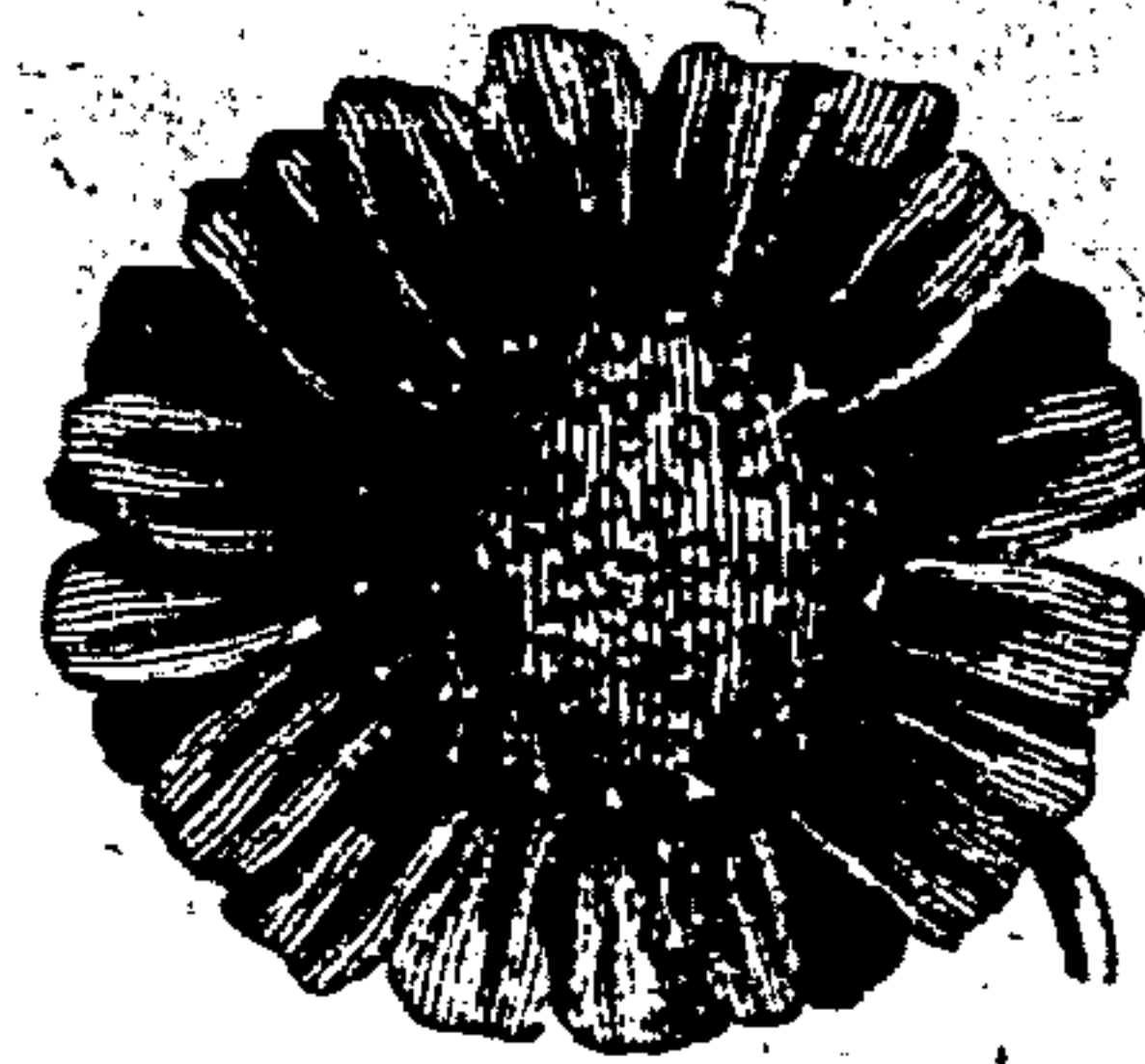
SILICULOSA



SILIQUOSA



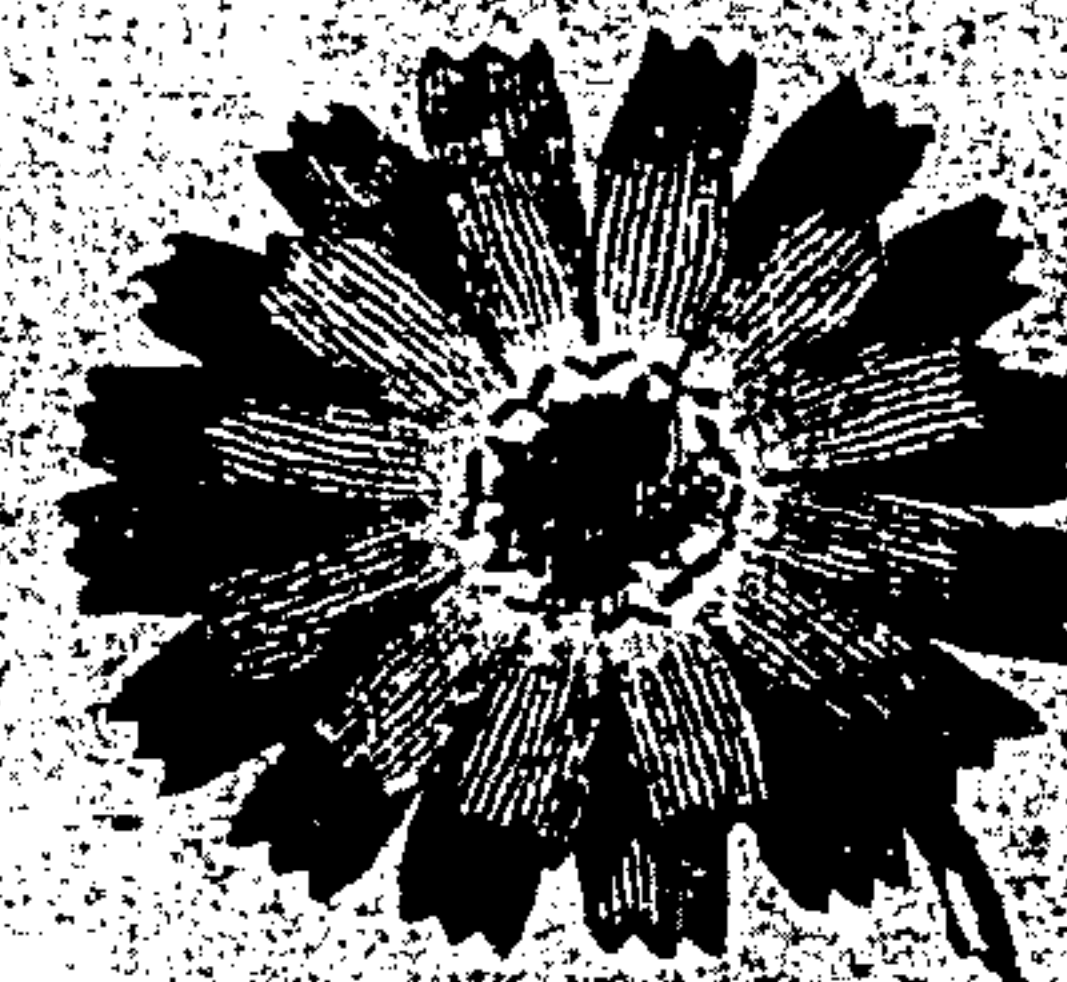
POLYGAMIA AQUALIS



POLYGAMIA SUPERFLUA



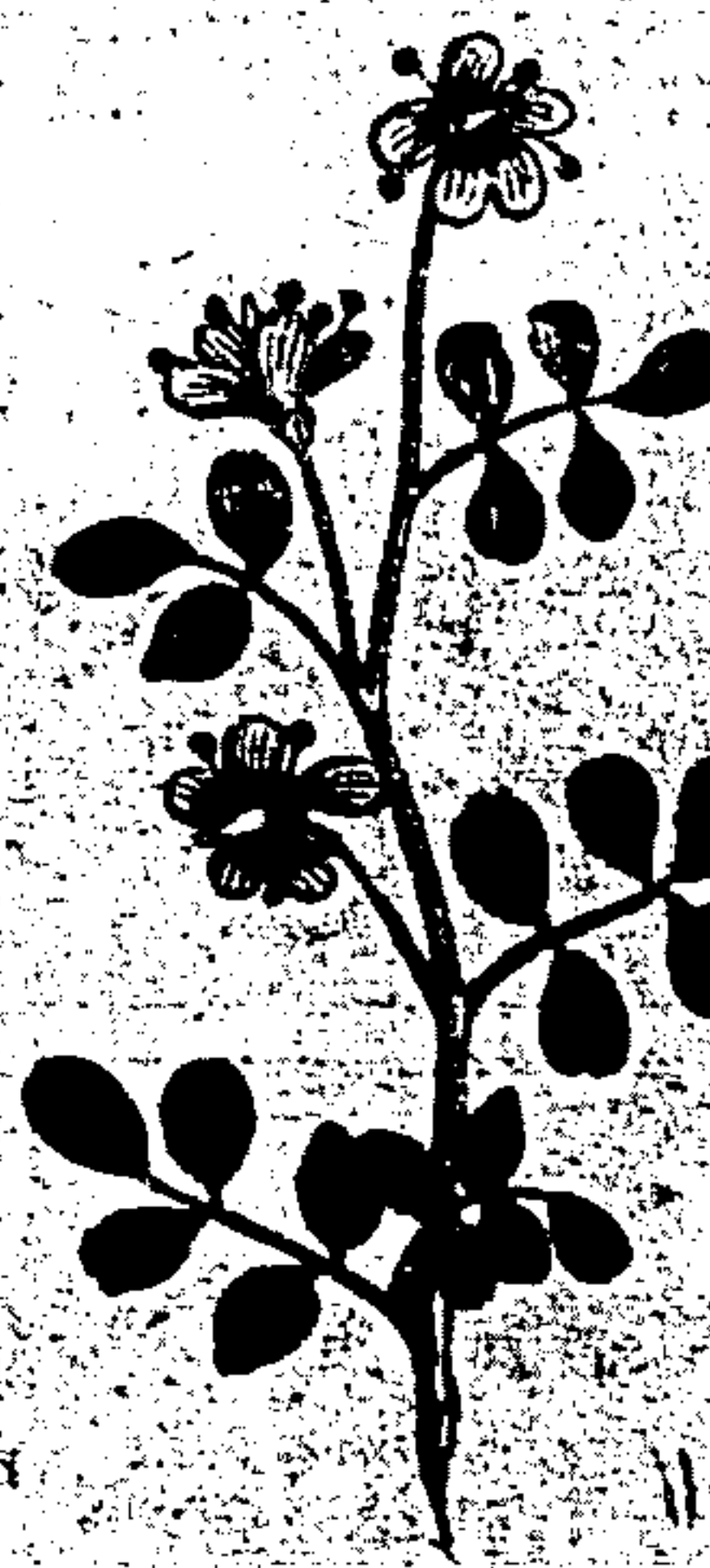
POLYGAMIA FRUSTRANEA



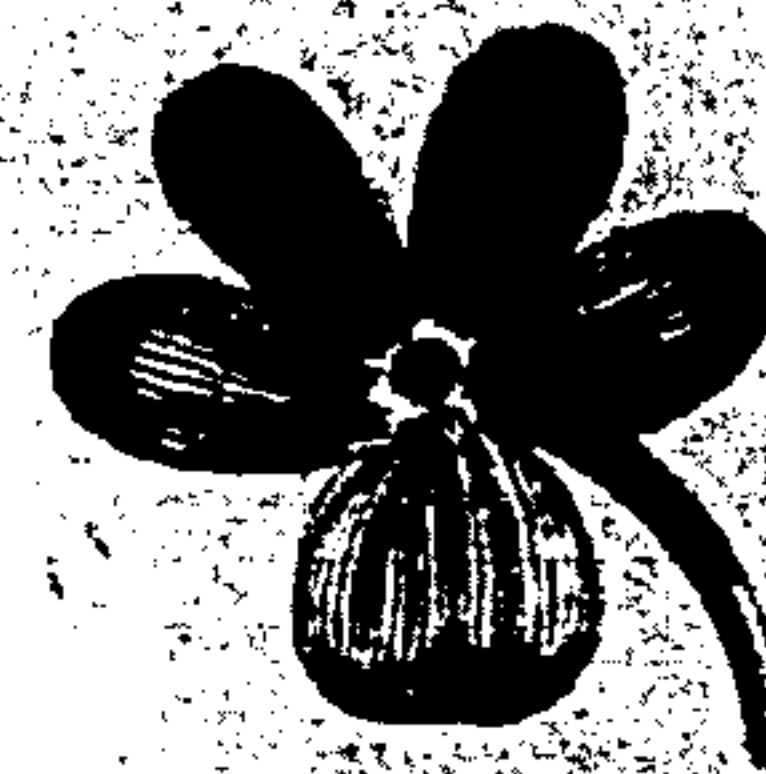
POLYGAMIA NECESSARIA



POLYGAMIA SEGREGATA



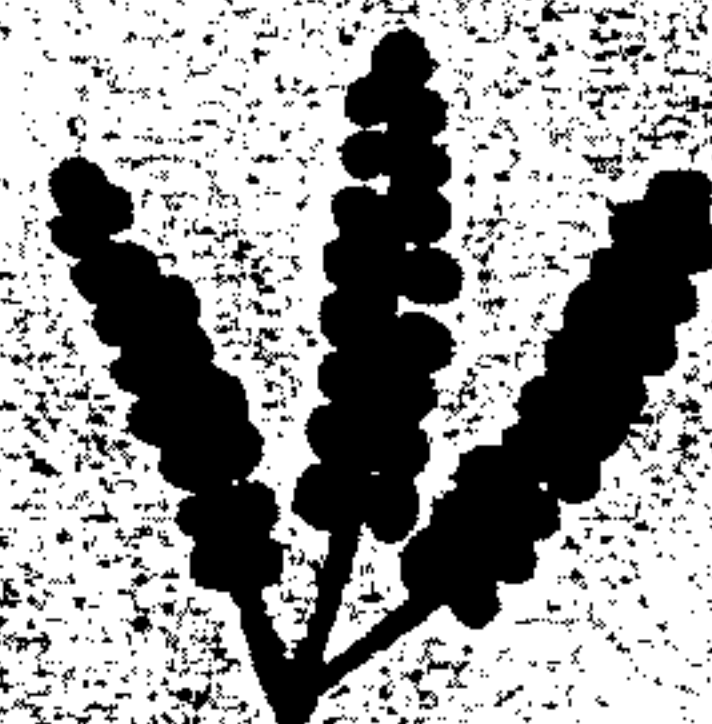
TRIOECIA



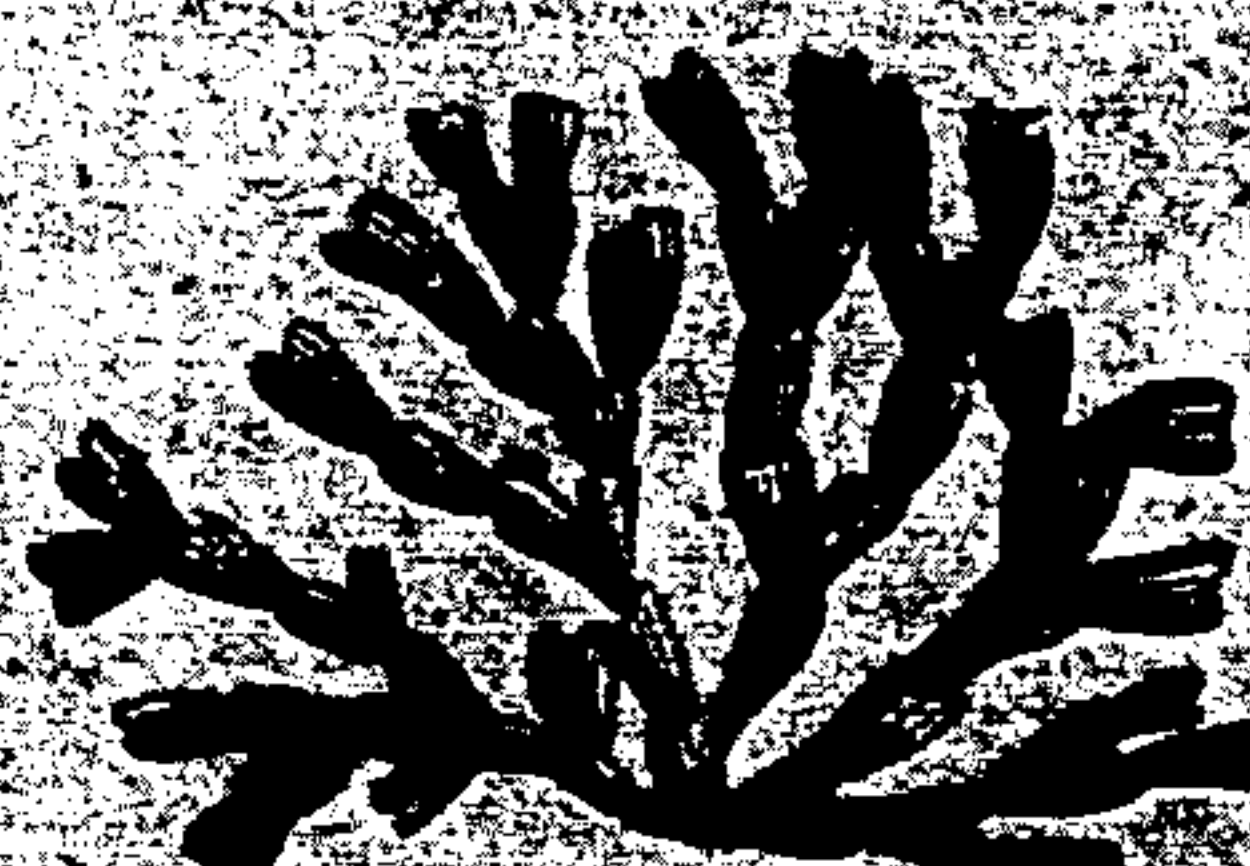
POLYGAMIA MONOGAMIA



FILICES



MUSCI



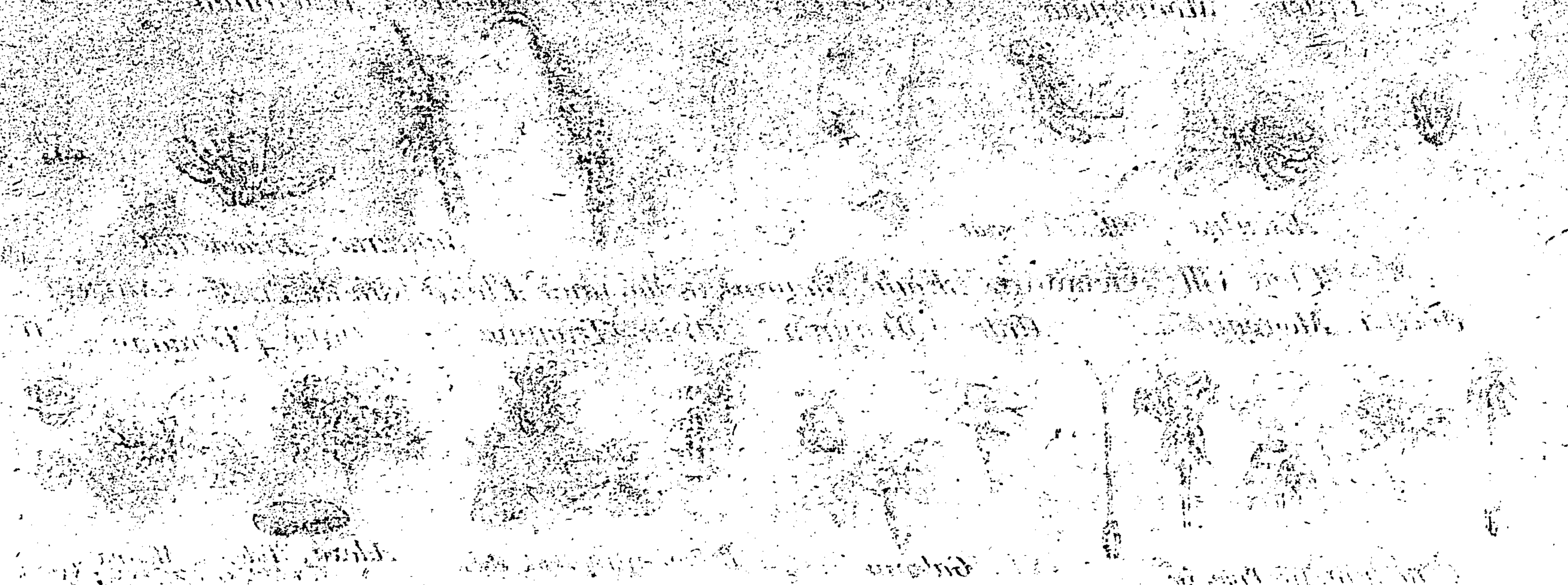
ALGAE



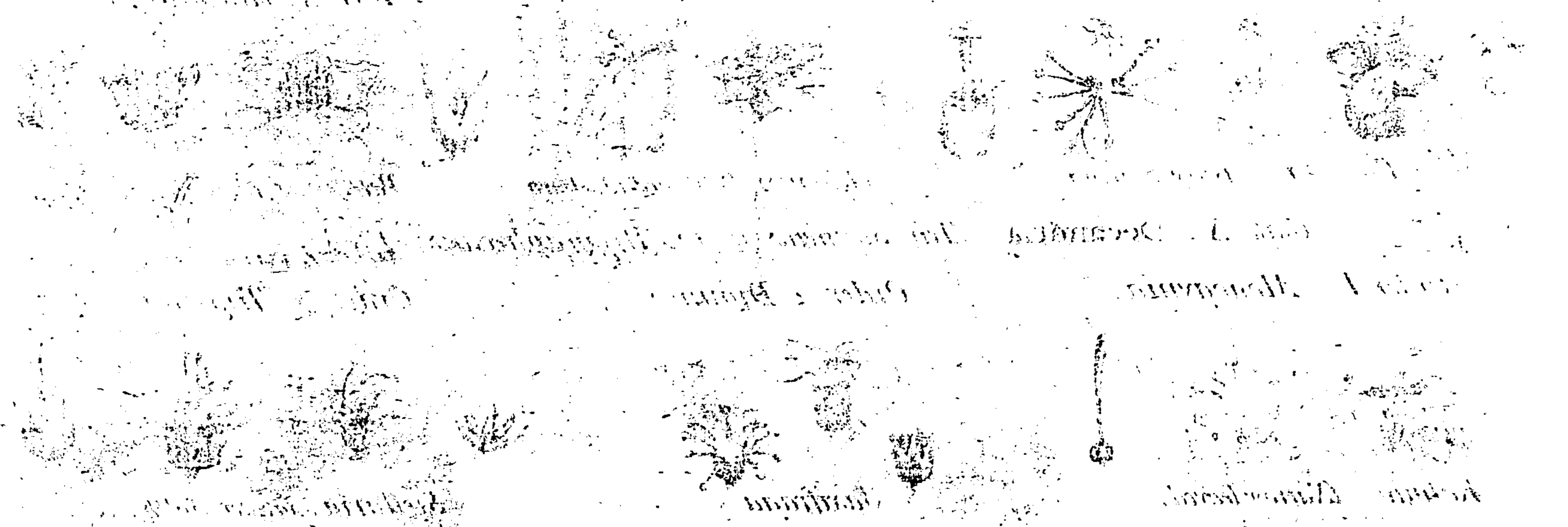
FUNGI



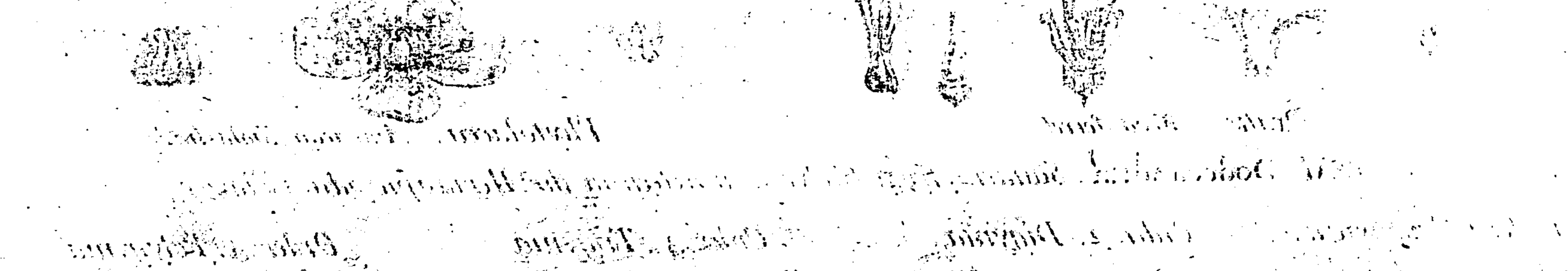
Class I. Monocotyledones  
Order 1. Gramineae



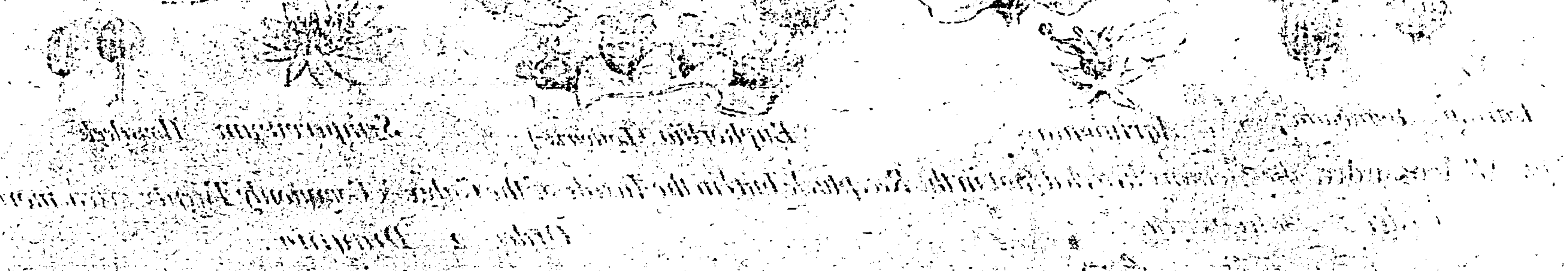
Order 2. Cyperaceae



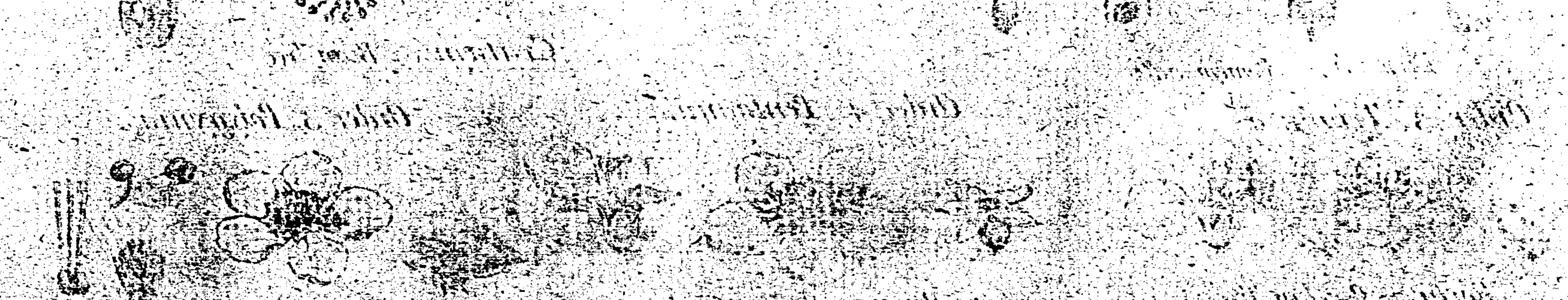
Order 3. Eriacaceae



Order 4. Juncaceae



Order 5. Poaceae



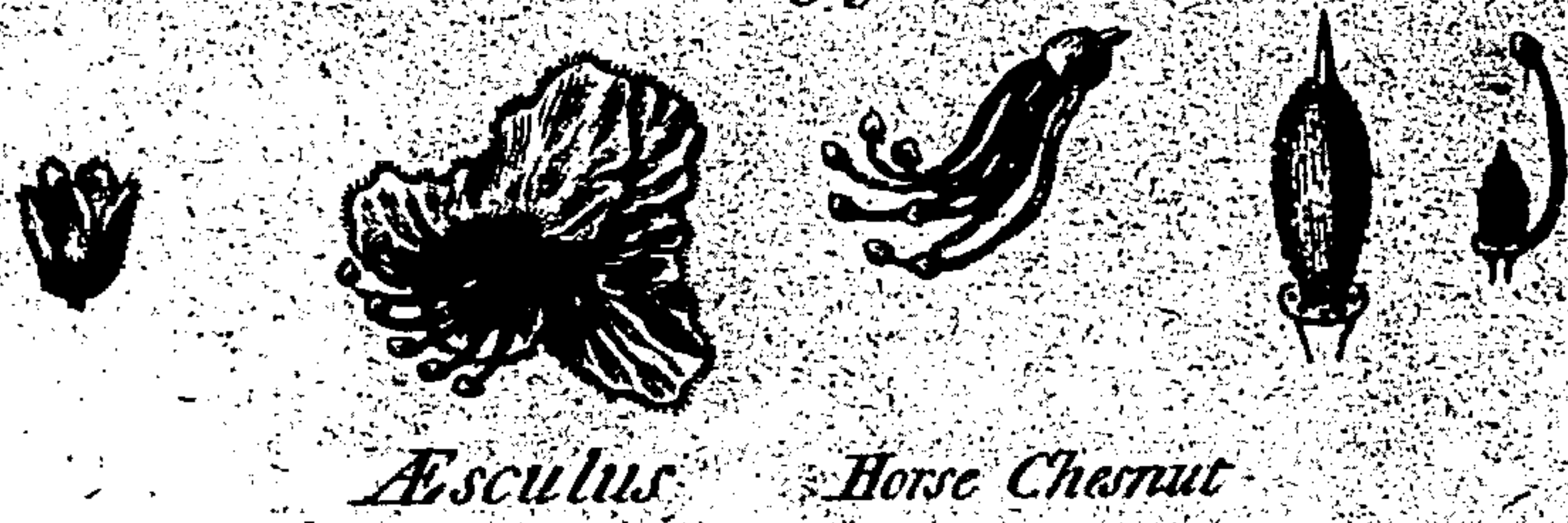


Linnean System.  
ORDERS OF FLOWERS.

Class VII. Heptandria. Seven Stamens on the same Flower with the Pistil.

Order 1. Monogynia.

Order 3. Tetragynia.



*Æsculus* Horse Chestnut



*Saururus*, Lizards Tail

Class VIII. Octandria. Eight Stamens in the same Flower with the Pistil.

Order 1. Monogynia.

Order 2. Digynia.

Order 3. Trigynia.

Order 4. Tetragynia.



*Oenothera Tree Primrose*



*Galenia*



*Polygonum*, Buck-wheat



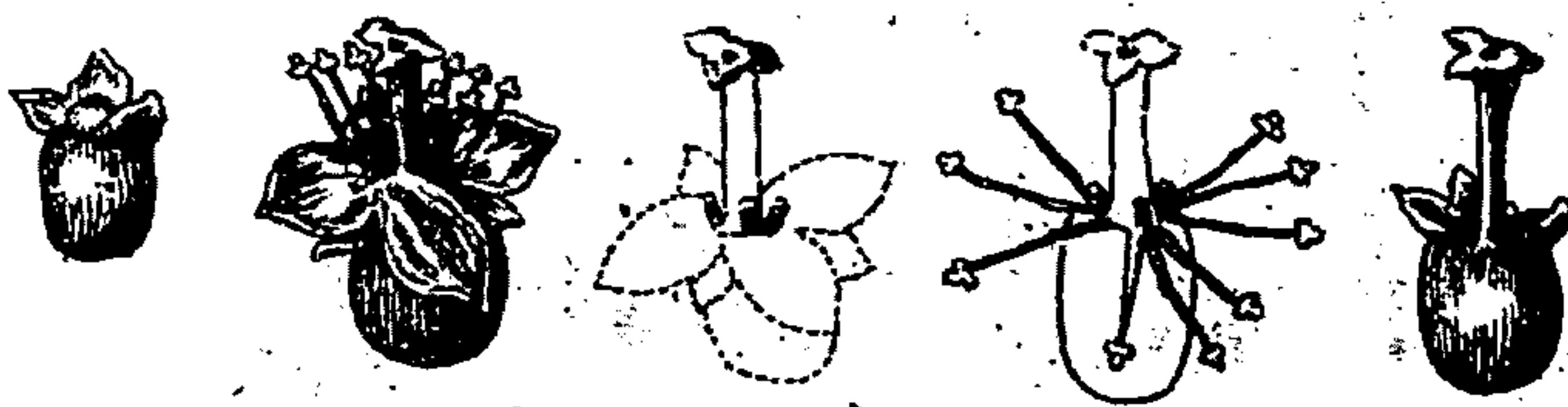
*Adoxa*, Tuberous Moschatel

Class IX. Enneandria. Nine Stamens in the Hermaphrodite Flower.

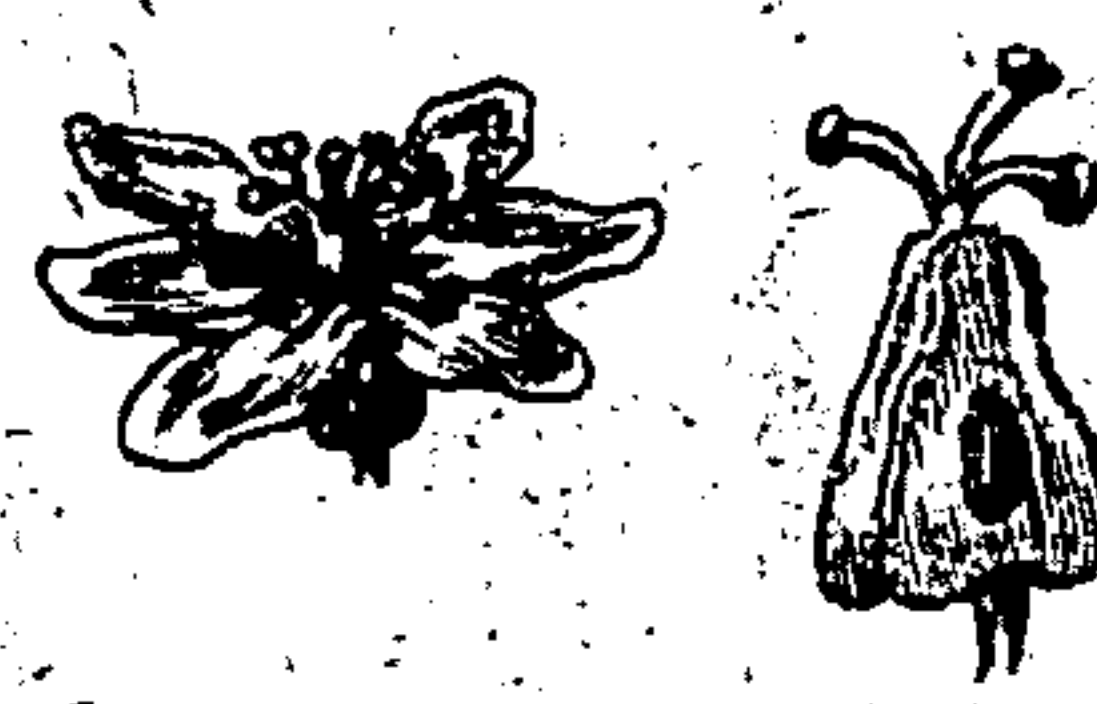
Order 1. Monogynia.

Order 2. Trigynia.

Order 3. Hexagynia.



*Cassia* (Berry-bearing)



*Rheum*, Palmated Rhubarb



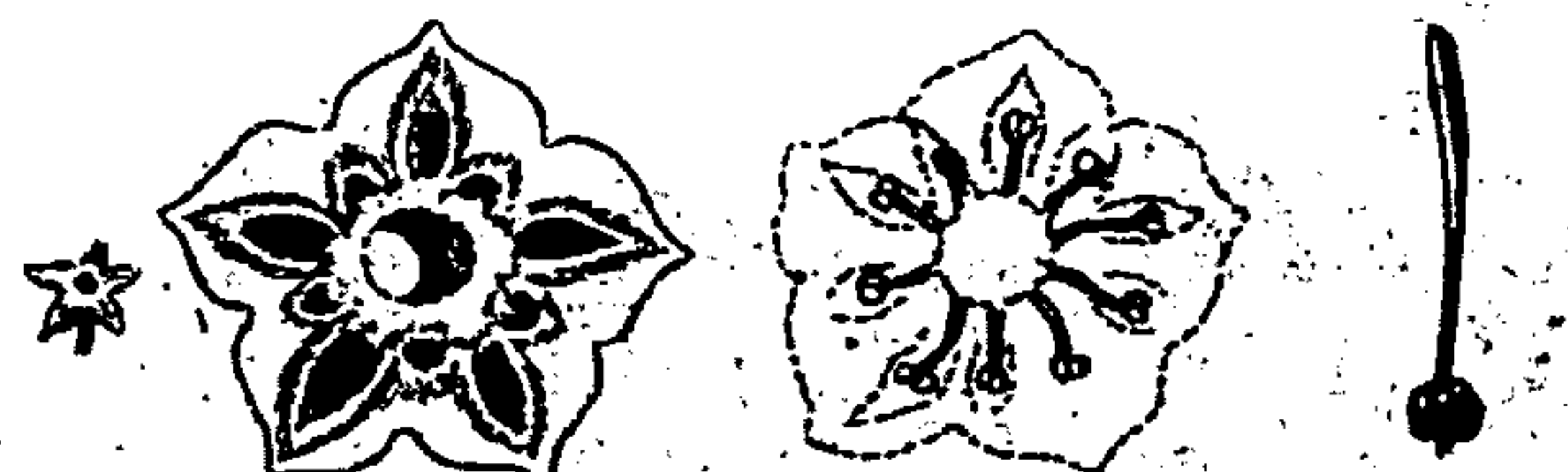
*Butomus*, Flowering Rush

Class X. Decandria. Ten Stamens in the Hermaphrodite Flower.

Order 1. Monogynia.

Order 2. Digynia.

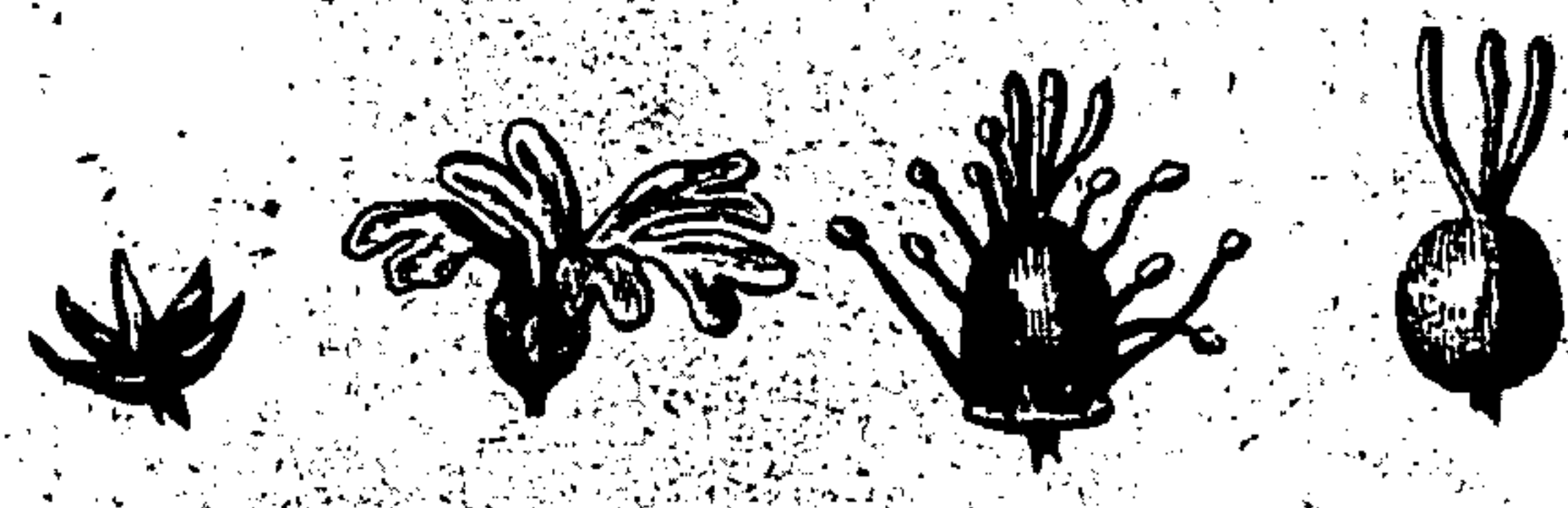
Order 3. Trigynia.



*Kalmia*, (Narrow leaved)



*Saxifraga*



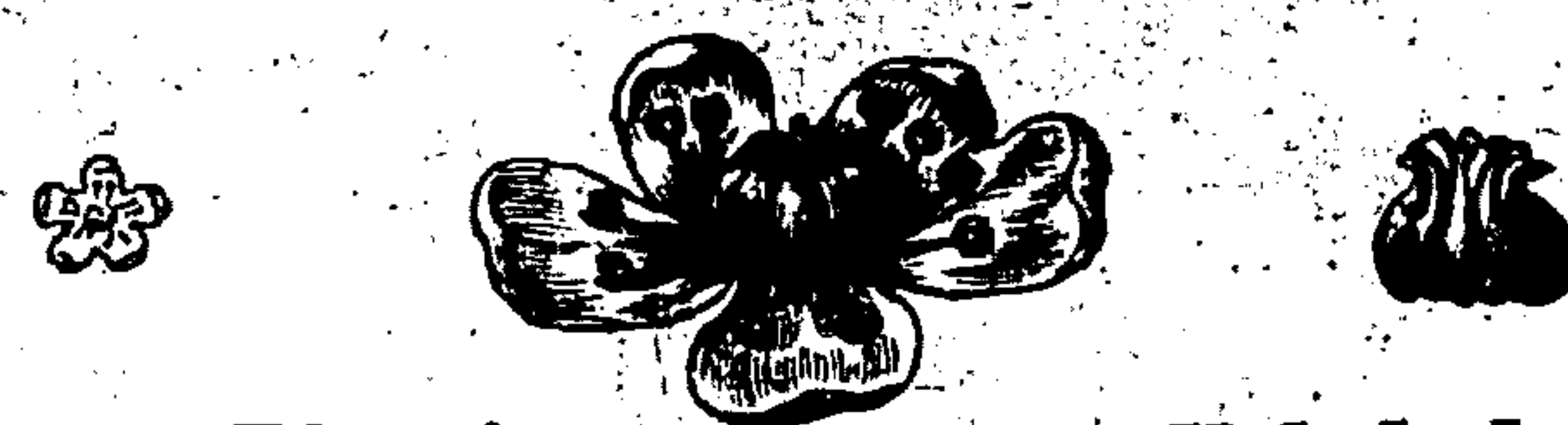
*Stellaria*, Greater Sulchwort

Order 4. Pentagynia.

Order 5. Decagynia.



*Oxalis* Wood Sorrel



*Phytolacca*, American Nightshade

Class XI. Dodecandria. Stamens from twelve to nineteen in the Hermaphrodite Flower.

Order 1. Monogynia.

Order 2. Digynia.

Order 3. Trigynia.

Order 5. Polygynia.



*Asarum*, Asarabacca



*Agrimonia*



*Euphorbia*, (Lathyrus)



*Sempervivum* Houseleek

Class XII. Icosandra. the Stamens inserted (not in the Receptacle but) in the Inside of the Calyx & Commonly Twenty often more.

Order 1. Monogynia.

Order 2. Digynia.



*Punica*, Pomegranate

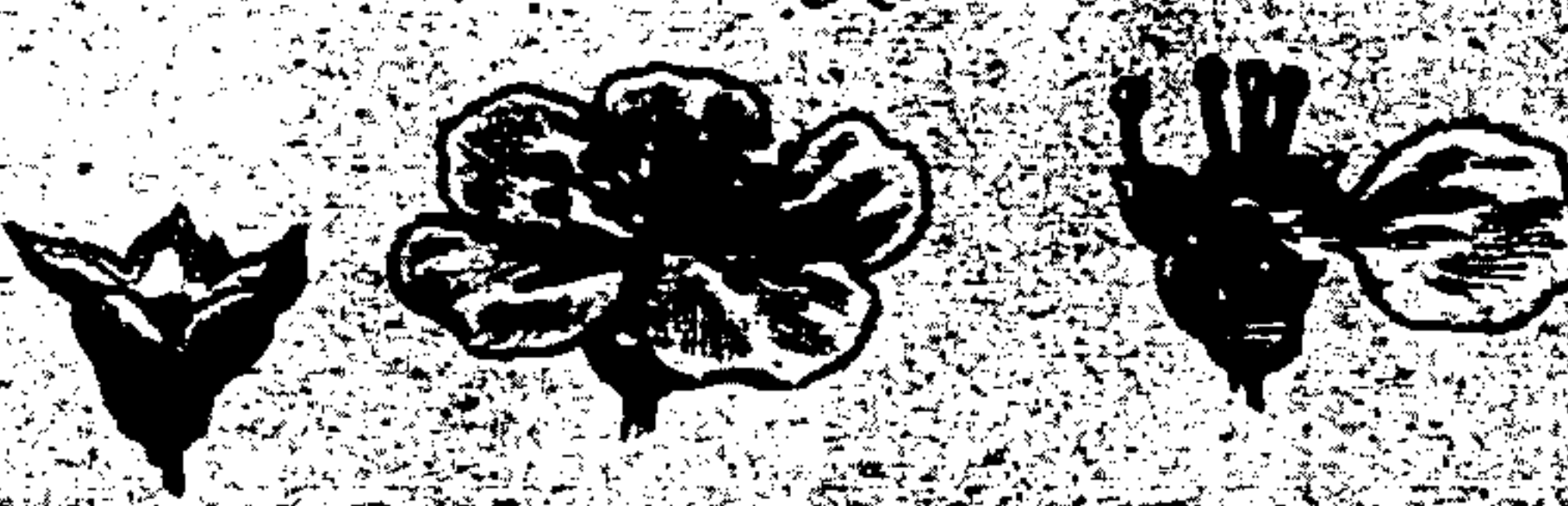


*Crataegus*, Bean Tree

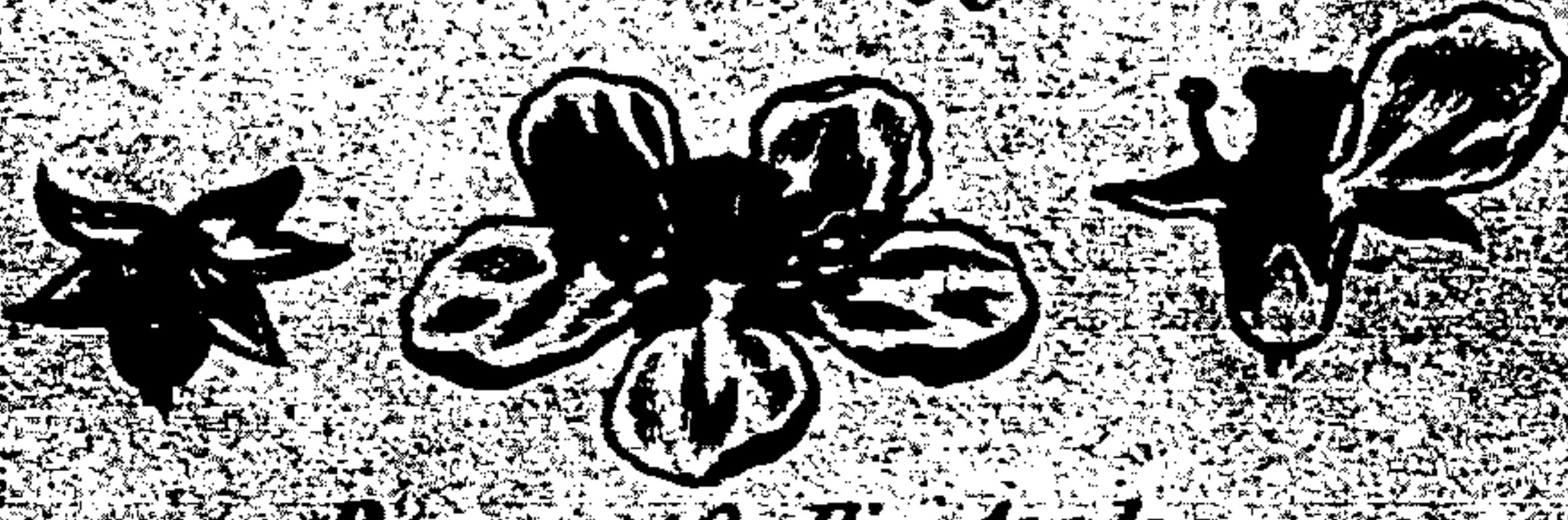
Order 3. Trigynia.

Order 4. Pentagynia.

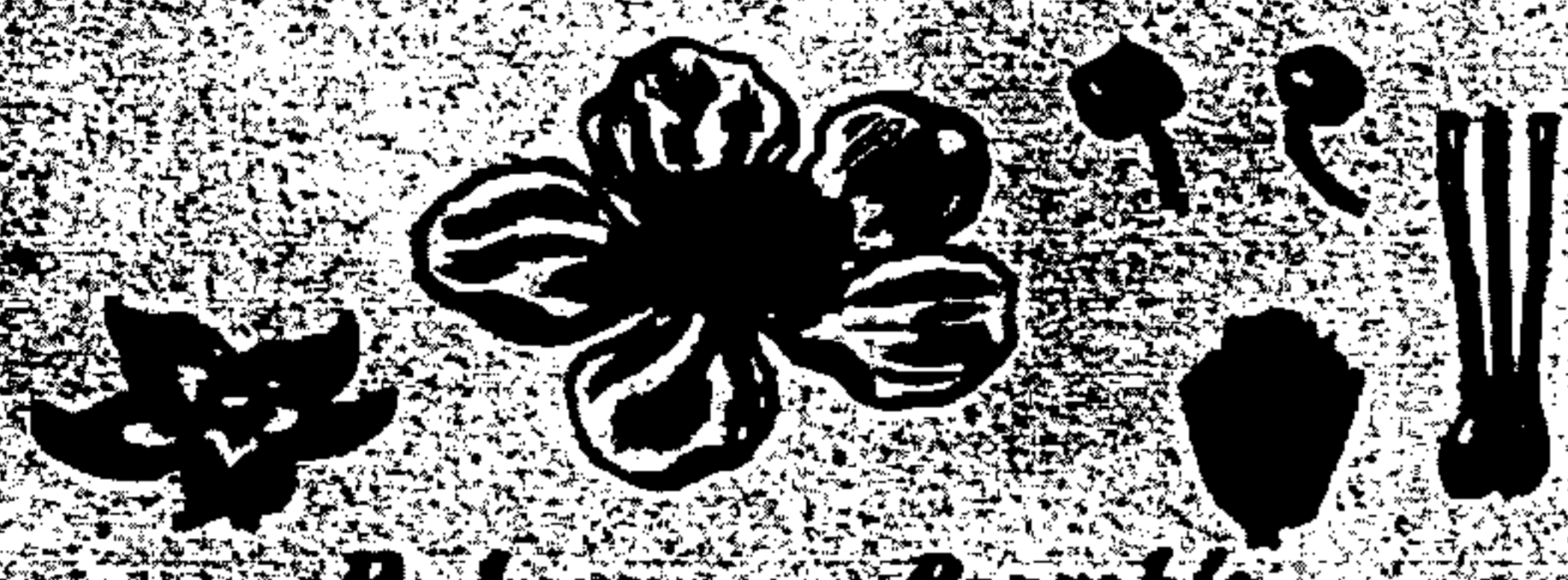
Order 5. Polygynia.



*Sorbus*, Quacken Tree

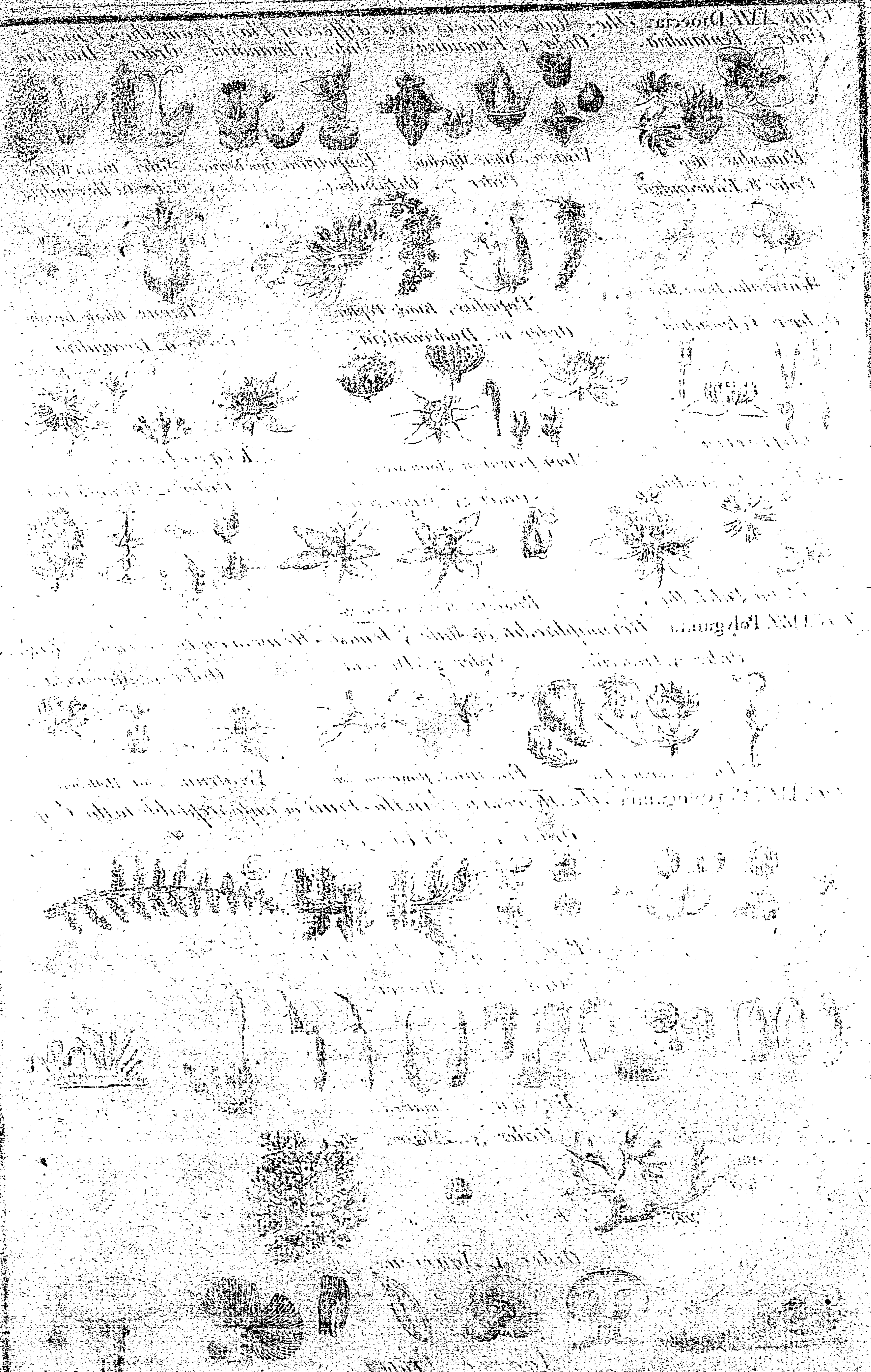


*Pyrus*, Codlin Apple



*Rubus*, Bramble







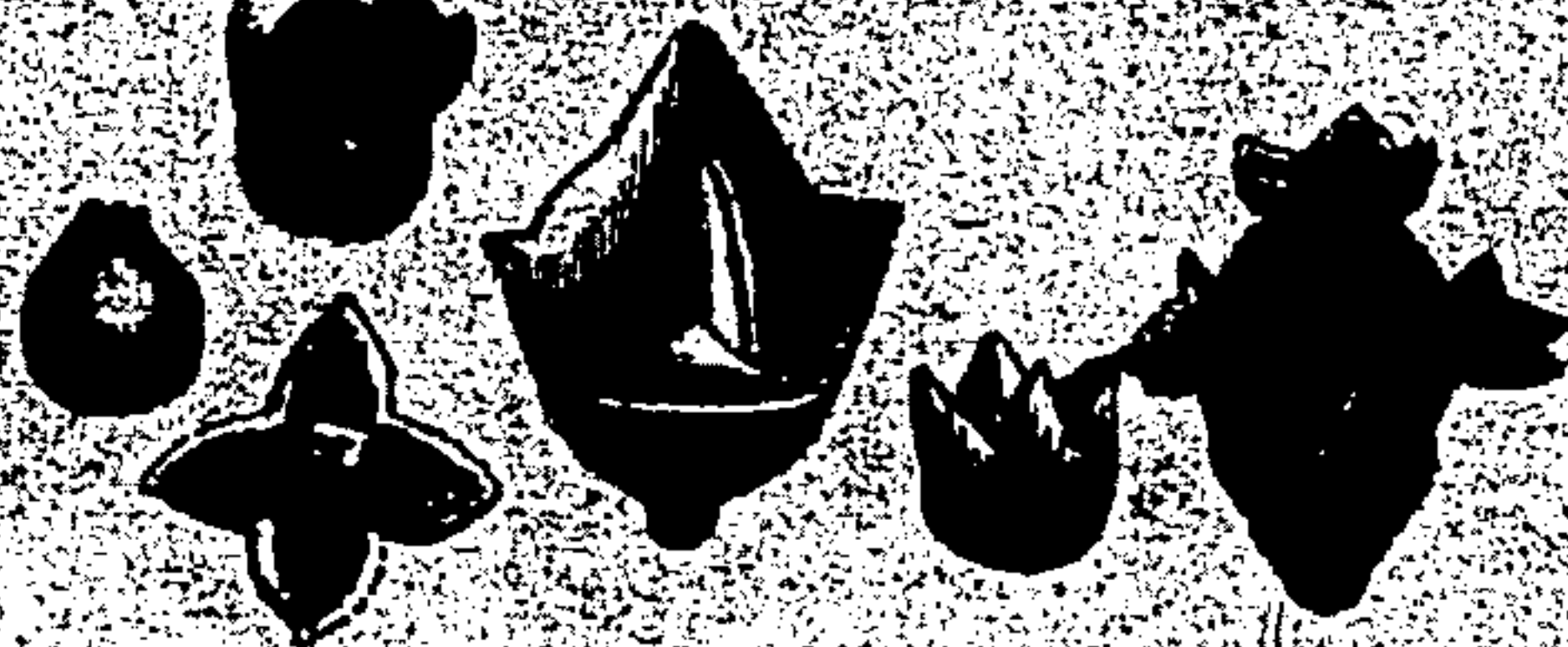
# B O T A N Y.

## LINNEAN SYSTEM—ORDERS of FLOWERS.

*Class XXII. Dioecia. The Male Flowers on a different Plant from the Female.*  
*Order 5. Pentandria.*      *Order 4. Tetrandria.*      *Order 3. Triandria.*      *Order 2. Diandria.*



*Humulus, Hop.*



*Viscum, White Mistletoe.*



*Empetrum, Cowberries.*



*Salix, Brown Willow.*



*Mercurialis, Dogs Mercury.*



*Populus, Black Poplar.*



*Tamus, Black Bryony.*



*Cliffortia.*



*Menispermum, Moon seed.*



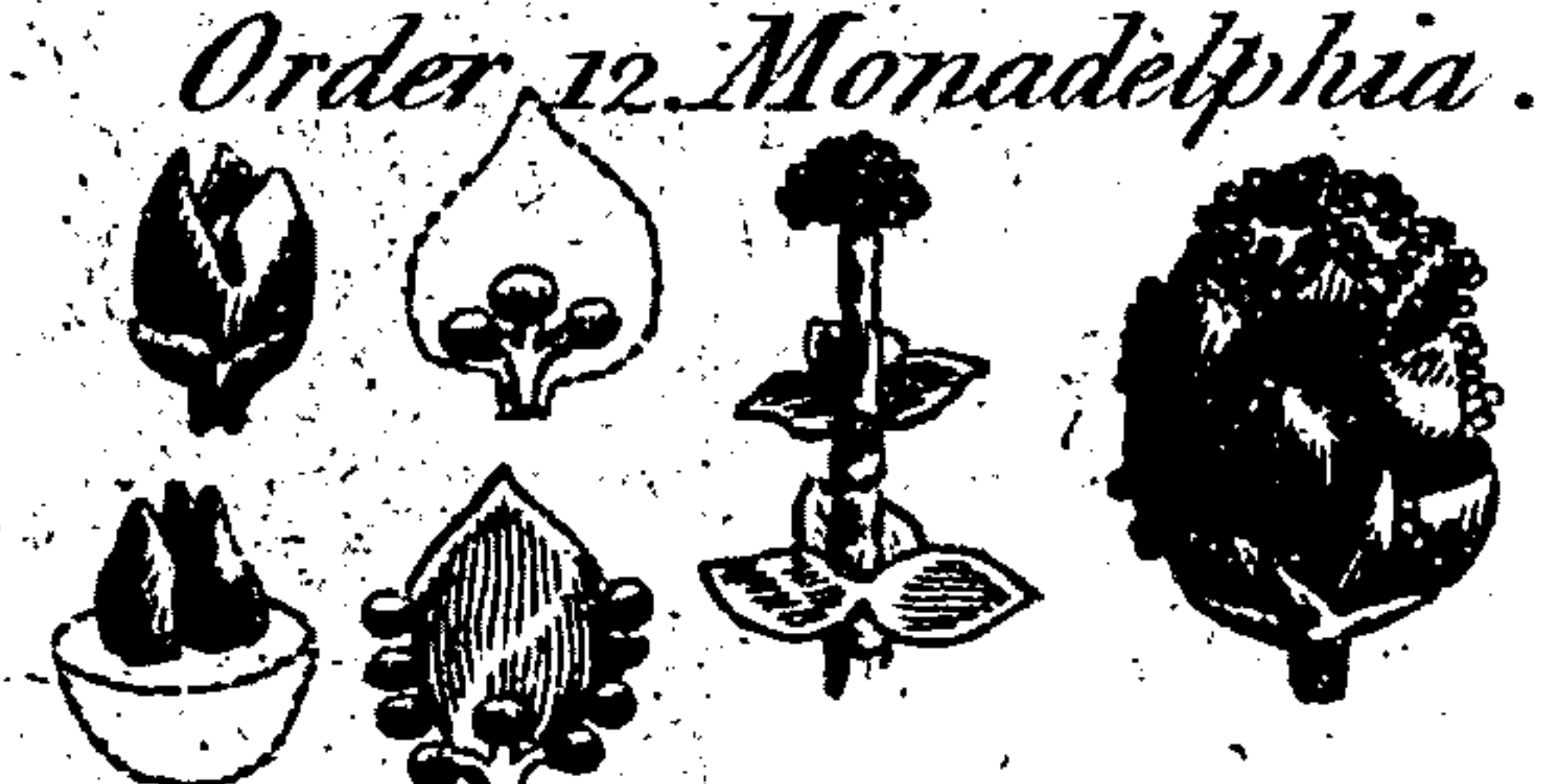
*Kiggelaria.*



*Clutia Pulchella.*



*Ruscus, Butchers Broom.*



*Juniperus, Juniper.*

*Class XXIII. Polygamia. Hermaphrodite, or Male & Female Flowers on the same Plant.*

*Order 3. Trioecia.*

*Order 2. Dioecia.*

*Order 1. Monoecia.*



*Ficus, common Fig.*



*Fraxinus, flowering Ash.*



*Veratrum, white Hellebore.*

*Class XXIV. Chryptogamia. The Flowers within the Fruit or imperceptable to the Eye.*

*Order 1. Filices.*



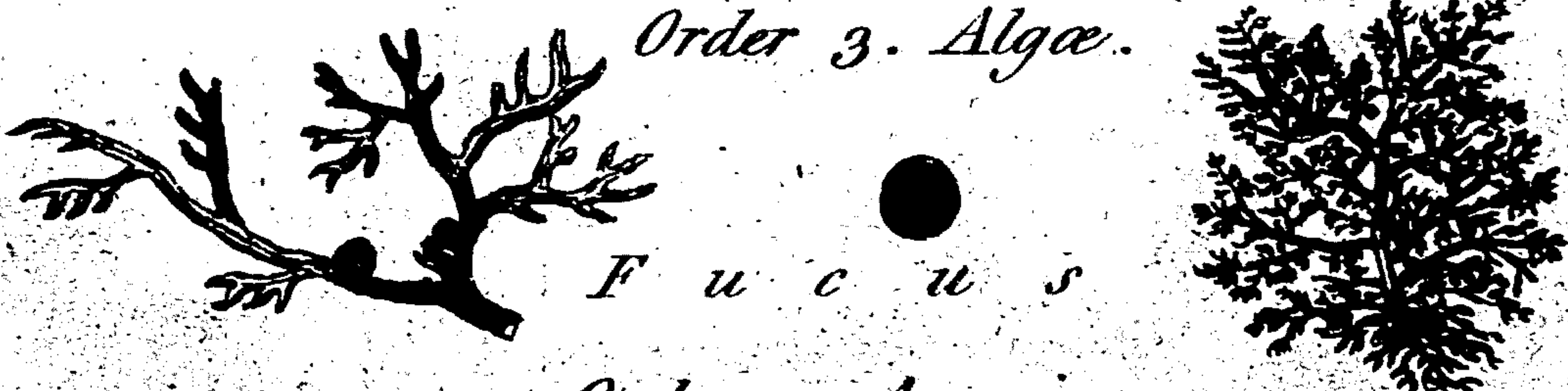
*Polypodium*

*Order 2. Musci.*



*Bryum. (matted).*

*Order 3. Algæ.*



*Fucus*

*Order 4. Agaricus.*



*Agaric (Field)*







*Linnean System*

ORDERS of FLOWERS.

*Class I. Monandria. One Stamen in the Hermaphrodite Flower*

Order 1. Monogynia



*Canna, Indian Flowering Reed*

Order 2. Digynia



*Blitum, Virgate Strawberry Blite*

*Class II. Diandria. Two Stamens in the Hermaphrodite Flower*

Order 1. Monogynia



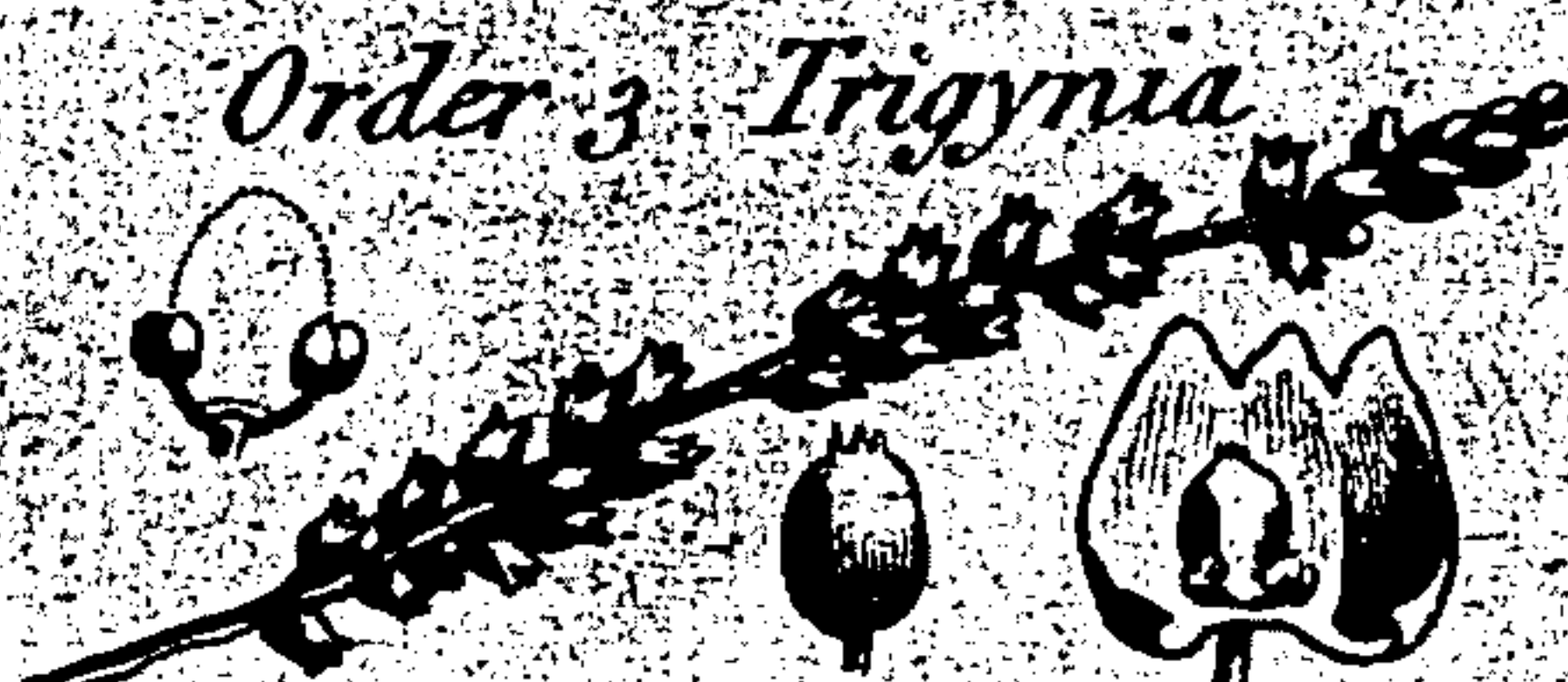
*Monarda, Oswego Tea*

Order 2. Digynia



*Anthoxanthum, Vernal Grass*

Order 3. Trigynia



*Piper, Black Pepper*

*Class III. Triandria. Three Stamens in the Hermaphrodite Flower*

Order 1. Monogynia



*Crocus, Garden Crocus*

Order 2. Digynia



*Avena Fatua, Wild Oat*

Order 3. Trigynia



*Mollugo, (verticillate)*

*Class IV. Tetrandria. Four Stamens in the Flower with the Fruit*

Order 1. Monogynia



*Dipsacus, Lacinated Teasel*

Order 2. Digynia



*Hamamelis, witch Hazel*

Order 3. Tetragynia



*Potamogeton, Pond weed*

*Class V. Pentandria. Five Stamens in the Hermaphrodite Flower*

Order 1. Monogynia



*Nerium, Rose Bay*

Order 2. Digynia



*Anethum, Common Fennel*

Order 3. Trigynia



*Turnera*

Order 4. Tetragynia



*Parnassia, Grass of Parnassus*

Order 5. Pentagynia



*Gratiola, Nodewort*

Order 6. Polygynia



*Myosurus, Mouse Tail*

*Class VI. Hexandria. Six Stamens in the Hermaphrodite Flower*

Order 1. Monogynia



*Amaryllis, Belladonna*

Order 2. Digynia



*Oryza, Rice*

Order 3. Trigynia



*Rumex, great curled Dock*

Order 4. Tetragynia



*Petiveria*

Order 5. Polygynia



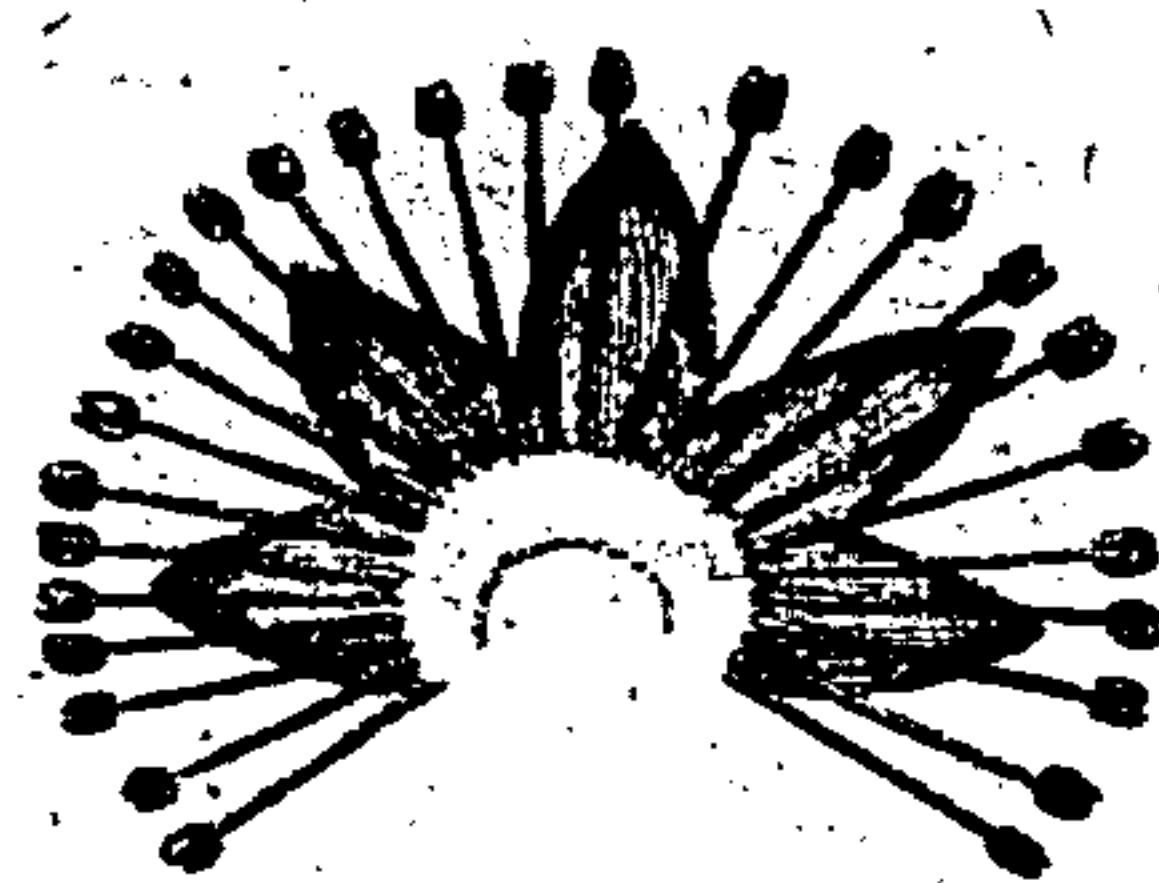
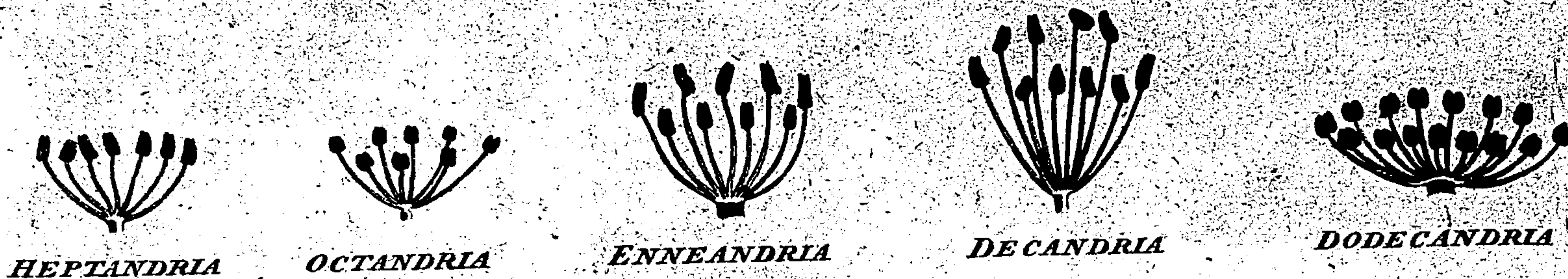
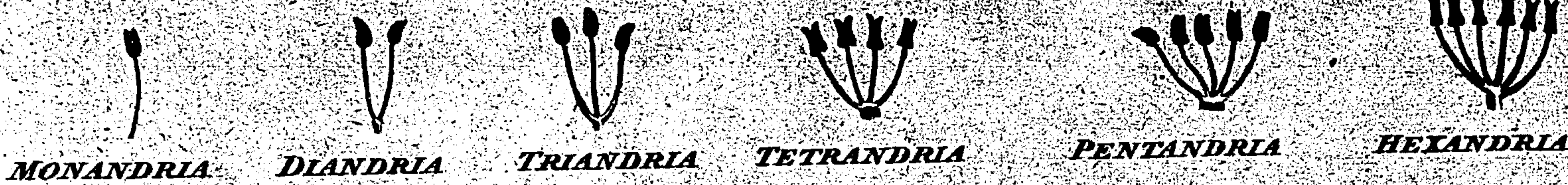
*Alisma, great water Plantain*







## Linnean System.



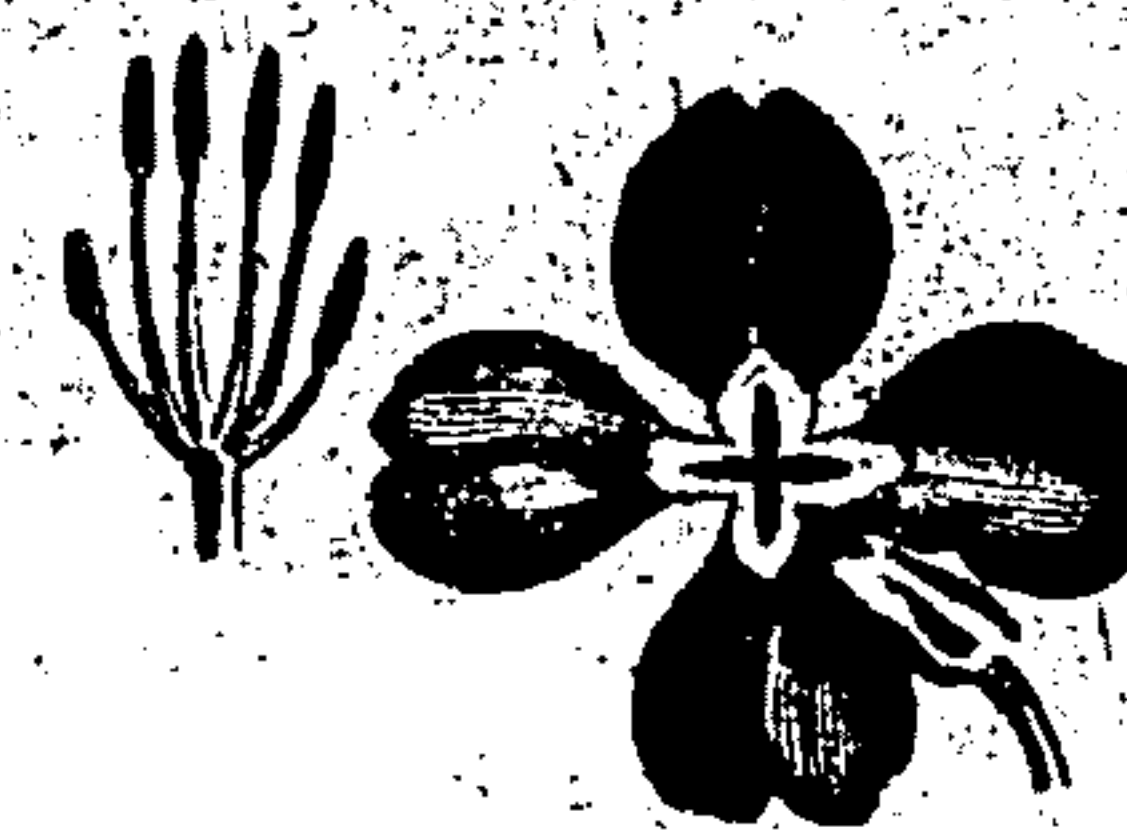
ICOSANDRIA.



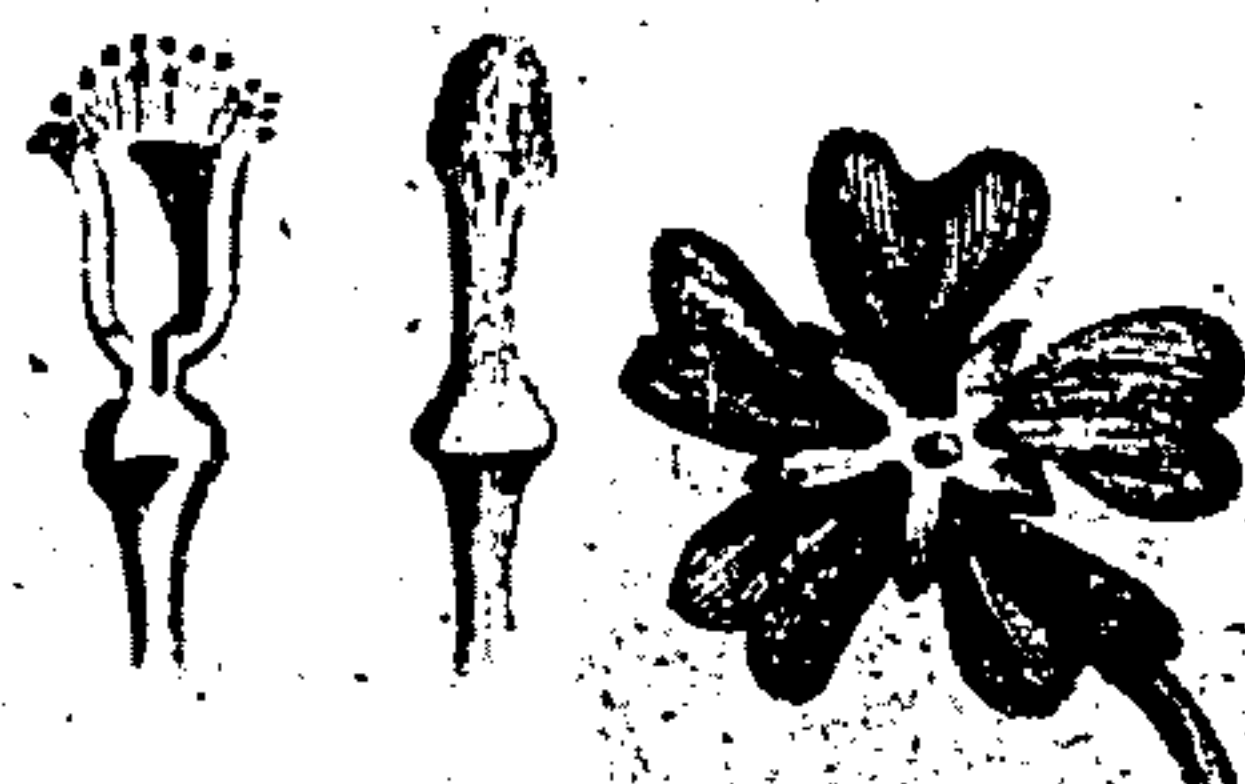
POLYANDRIA



DIDYNAMIA



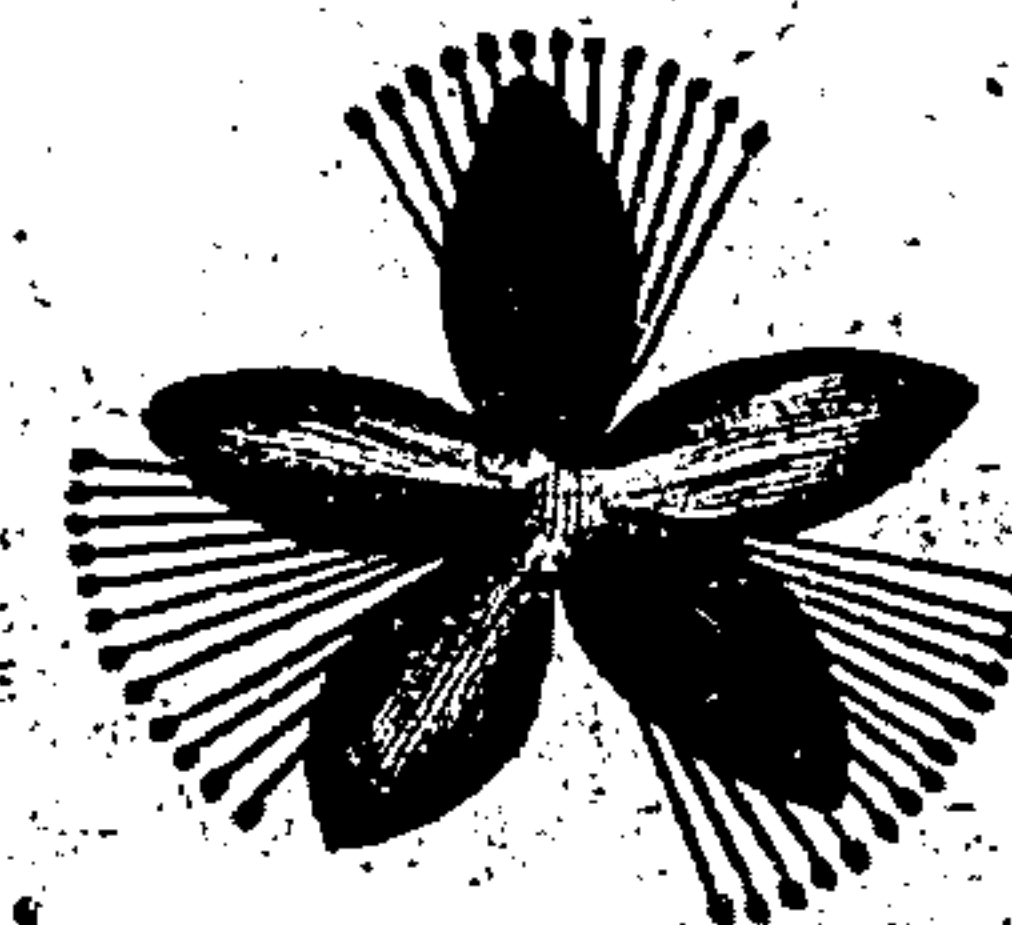
TETRADYNAMIA



MONADELPHIA



DIADELPHIA



POLYADELPHIA



SYNGENESIA



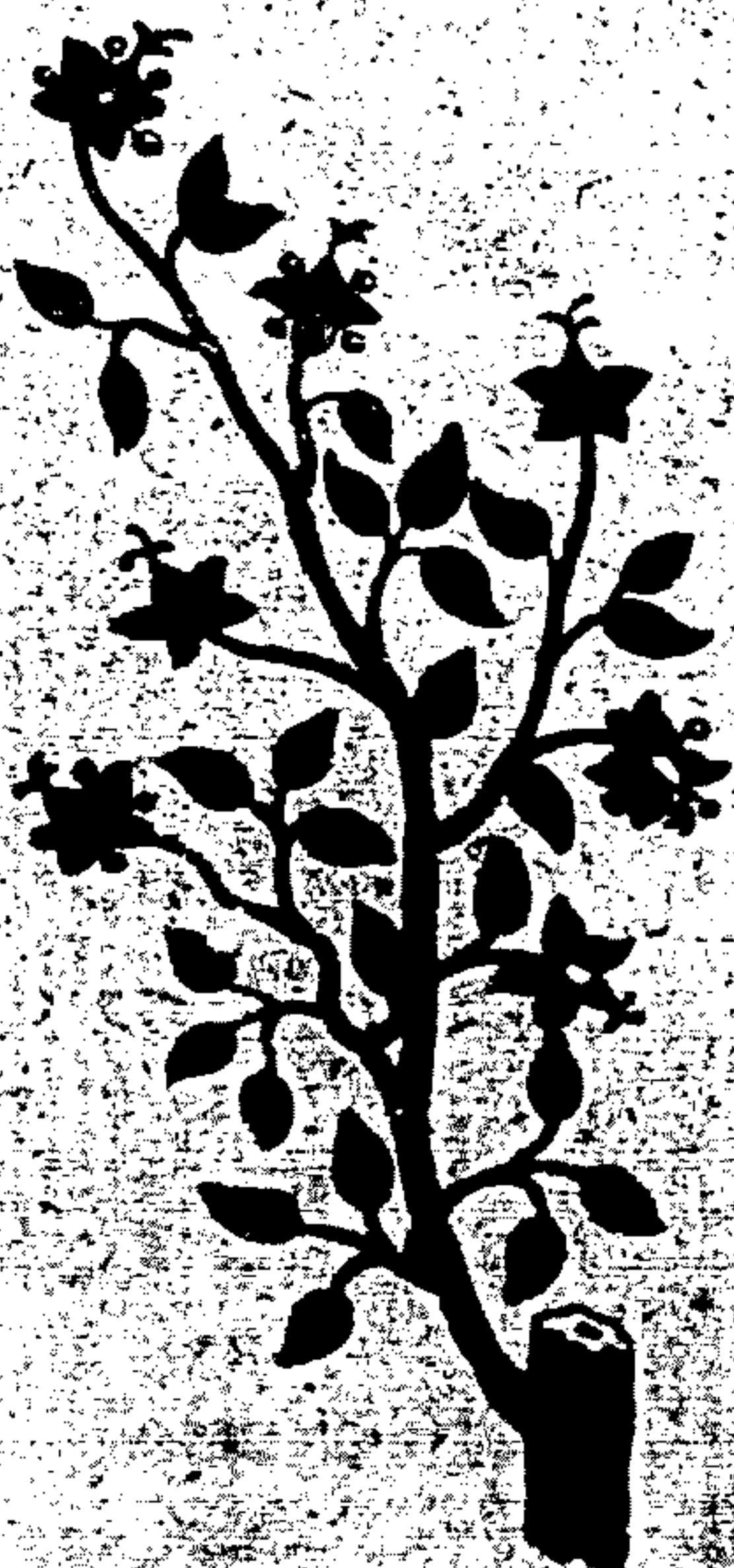
GYNANDRIA



MONOECLIA



DIOECIA



POLYGAMIA



CRYPTOGAMIA



## THE LINNÆAN SYSTEM,

Containing the Various Orders or Classes of Flowers, such are;

I. **THOSE** that have one stamen on the hermaphrodite flower, as,

The Indian Flowering Reed, or Cane, of which there are three species. 1. Common broad-leaved Flowering Cane. 2. Indian Flowering Cane, with a pale red flower. 3. Indian Cane, with glaucous leaves, and a very large flower—The Virgate Strawberry Blite. 1. Blite with spikes, terminated with little heads, or the common Strawberry Blite, or Strawberry Spinach. 2. Blite with small heads growing scattered from the sides of the stalks.

II. Two stamens in the hermaphrodite flower, as,

Ofwego Tea, having headed flowers; the stamina of which are almost in two bodies, and an acute angular stalk—Vernal Grass—Black Pepper.

III. Three stamens in the hermaphrodite flower, as,

The Garden Crocus. 1. That with a spatha of one valve near the root, with a very long tube to the flower, being the cultivated, or true Saffron—2. The Crocus, with a two leaved spatha, and a short tube to the flower—The wild Oat—and the Melugo (verticillate.)

IV. Four stamens in the flower with the fruit, as,

Lacinated Teasel—Witch Hazel, a genus of plants, of which there is but one species—Pond Weed.

V. Five stamens in the hermaphrodite flower, as,

Rose Bay. 1. Oleander or Nerium, with linear, spear-shaped leaves, three at a joint. 2. Oleander, with spear-shaped, ovated leaves, and divaricated branches. 3. Oleander, with oval, accumulated foot stalks—Common Fennel, a biennial plant—Turnera. 1. With linear, spear-shaped, hairy leaves. 2. With oval, spear-shaped leaves, sawed, and rough—Grass of Parnassus. 1. Common Marsh-grass of Parnassus. 2. Grass of Parnassus, with double flowers—Navelwort. 1. Navelwort with roundish, plane, intire leaves. 2. Navelwort with semiglobular leaves. 3. Navelwort with oval crenated leaves, and a spiked stalk. 4. Navelwort with oblong pointed leaves ending with a spine, and a spiked stalk. 5. Navelwort with hooded leaves sharply indented, and growing alternate, and a branching stalk with erect flowers. 6. Navelwort with cut leaves, and four pointed flowers.

The first and second species are shrubby plants, and natives of the Cape of Good Hope. They flower in the months of July and August, but never ripen seeds in this country.

The third species is a biennial plant, and grows naturally in Crete and Siberia. The fourth is also a native of Siberia.

The fifth species grows upon old walls and other buildings in many parts of England and Portugal, and is seldom cultivated in gardens.

The sixth species is a native of Egypt. It is a shrubby plant, and requires a warm stove to preserve it through the winter in this country; nor should it be exposed abroad in summer, but kept in the stove, or placed in an airy glass case—Moult-tail.

VI. Six stamens in the hermaphrodite flower, as,

Belladonna—Rice—Great-curved Dock—Petiveria—and Great Water Plantain.

VII. Seven stamens in the same flower, with the pistil, as,  
Horse Chestnut—Lizard's Tail.

VIII. Eight stamens in the same flower with the pistil, as,

The Tree Primrose. 1. With oval spear-shaped, plain leaves. 2. With spear-shaped, waved leaves. 3. With spear-shaped leaves, and capsules which have acute angles. The first and third species are natives of Virginia, and the second of Buenos Ayres—Galenia. It grows naturally at the Cape of Good Hope, and in other parts of Africa—Buck-Wheat—Tuberous Moschatel.

IX. Nine Stamens in the hermaphrodite flower, as,

Cassia (Berry-bearing)—Palmated Rhubarb—Flowering Rush.

X. Ten stamens in the hermaphrodite flower, as,

Calmia, narrow leaved—Saxifraga—Greater Storchwort—Wood Sorrel, of which there are thirteen species, but five of these only are cultivated in gardens; viz. 1. Wood Sorrel, with a foot-stalk supporting one flower, trifoliate leaves, and a bulbous root. 2. Wood Sorrel, with one flower on a foot-stalk, and stalks divided by pairs. 3. Wood Sorrel, with an umbelliferous stalk, and trifoliate leaves, divided into two parts. 4. Wood Sorrel, with a branching, diffused stalk, and umbellated foot-stalks. 5. Wood Sorrel, with a branching, upright stalk, and umbellated foot-stalks.

The first, second, and third species are natives of Africa. The fourth of Italy and Sicily; and the fifth of Virginia—American Nightshade: of which most botanists enumerate a vast number of species, but some writers have reduced them to the twenty-three following. 1. Night-shade, with a shrubby, unarmed stalk, oval, hairy, entire leaves, and compound umbels. 2. Night-shade, with a shrubby, unarmed stalk, oval, entire leaves, and thread-like foot-stalks to the flowers, proceeding from the sides of the branches. 3. Night-shade, with a shrubby, unarmed stalk, spear-shaped leaves, turning inward, and umbels fitting close to the stalks. 4. Night-shade, with a shrubby, unarmed stalk, leaves growing in pairs, one of which is bigger than the other, and cymose flowers. 5. Night-shade, with a shrubby, bended, and unarmed stalk, the upper leaves spear-shaped, and bunches of flowers at the top of the stalk, commonly called Bitter-sweet. 6. Night-shade, with a shrubby, bended, and unarmed stalk, oblong, sinuated leaves, at the sides of the stalk, and bunches of flowers at the top of the stalk. 7. Night-shade, with a shrubby, almost unarmed stalk, and wedge-shaped, sinuated leaves, turning backward. 8. Night-shade, with an herbaceous, unarmed stalk, and entire, winged-leaves. 9. Night-shade, with an unarmed, herbaceous stalk, cut, winged leaves, and single bunches of flowers, or Pomum amoris. 10. Night-shade, with an herbaceous, unarmed stalk, cut, winged leaves, bunches of reflexed flowers divided into two parts, and hairy berries. 11. Night-shade, with an herbaceous, unarmed stalk, and heart-shaped leaves, turning inward. 12. Night-shade, with an unarmed, herbaceous stalk, oval, indented, angular leaves, and nodding umbels; or the common Night-shade of the shops, with a black fruit. 13. Night-shade, with an unarmed, herbaceous stalk, oval, hairy, intire leaves, and prickly cups; or the Melongena, Mad-apple, or Egg-plant. 14. Night-



Night-shade, with a prickly, herbaceous stalk, heart-shaped, sinuated leaves, and prickly cups. 15. Night-shade, with a prickly, herbaceous stalk, and heart-shaped leaves with five lobes, hairy, and prickly on both sides, commonly called Batchelor's Pear. 16. Night-shade, with a prickly, herbaceous stalk, winged leaves, sinuated, obtuse segments, and prickly cups. 17. Night-shade, with a prickly, shrubby stalk, angular, woolly, intire leaves, prickly on both sides, and unarmed cups. 18. Night-shade, with a prickly, shrubby stalk, spear-shaped, angular leaves, prickly on both sides, and loose bunches of flowers. 19. Night-shade, with recurved thorns on the stalks, and sinuated leaves, downy on their under-side, prickly on both sides, and the foot-stalks of the flowers prickly. 20. Night-shade, with a prickly, shrubby stalk, leaves turned inside, and prickly cups. 21. Night-shade, with a prickly, shrubby stalk, heart-shaped, hairy leaves, turned in at the brim, and unarmed cups. 22. Night-shade, with a prickly, shrubby stalk, and spear-shaped, angular, indented leaves. 23. Night-shade, with a prickly, shrubby stalk, smooth, obtuse, unarmed leaves, with three lobes.

These plants are natives of Europe, Asia, Africa, and America, but most of them grow naturally in America.

XI. Stamens with twelve, nineteen in the hermaphrodite flower, as,

Asarum, Asarabacca. 1. With kidney-shaped leaves, having two blunt points, or the common Asarabacca. 2. Asarum, with kidney-shaped leaves, ending in a point. 3. Asarum, with blunt, heart-shaped, smooth leaves, with foot stalks. 4. Asarum, with sessile imbricated leaves, and flowers cut into four parts, or the hypocist. These are perennial plants: the first grows in some parts of England, and other countries of Europe. The second is a native of Canada: The third grows naturally in Virginia, Maryland, and Carolina; and the fourth is a native of Spain and Portugal—Agrimonia—Euphorbia (Lathyrus)—Sempervivum, Houseleek: of which are seven species. 1. Houseleek with a smooth, tree-like, branching stalk, or Tree Houseleek. 2. Houseleek with stalks torn by the rudiments of the leaves, and blunt pointed leaves. 3. Houseleek with hairy edged leaves, and spreading off-sets, or the common large Houseleek. 4. Houseleek, with hairy edged leaves, and globular off-sets. 5. Houseleek with threads from leaf to leaf, and globular off-sets. 6. Houseleek with entire leaves, and spreading off-sets. 7. Houseleek with leaves, whose borders are indented like a saw, and spreading off-sets.

The first species grows at the Cape of Good Hope, and in Portugal. The second is a native of the Canary Islands. The third is found growing on the tops of houses, and walls in England. The fourth is a native of the northern parts of Europe. The fifth grows upon the Alps and Helvetian mountains. The sixth upon the latter: and the seventh is a native of the Cape of Good Hope.

XII. The stamens inserted in the inside of the calyx; and commonly twenty, or more, as,

Punica, the Pomegranate: There is only one species of this genus with the following varieties. The wild, with single and double flowers. The small flowering with ditto. The Pomegranate with striped flowers; and the Sweet Pomegranate. The Tree is a native of Italy, Spain, and Africa—The Bean-tree—Quicken-tree—Codlin-apple—The Bramble.

XIII. The stamens from twenty to a hundred in the same pistil with the flower, as,

Sarracenia—The Piony—Wolfs-bane—Columbine. 1. With crooked nectaria, called Double Siatry. 2. With straight nectaria, shorter than the petals, which are sharp-speared. 3. With straight nectaria, and stamina longer than the flower petals. The first species grows naturally in most countries of Europe. The second is a native of Switzerland, and the third of Virginia and Canada.—Water Aloe, of which there are fourteen species. 1. Aloe, with nodding flowers, growing upon foot-stalks, in form of a cylindrical corymbus, or the common Aloe. 2. Aloe, with nodding, branching, prismatic flowers, growing upon foot-stalks, and spreading equally at the brim, commonly called Partridge-breast Aloe. 3. Aloe, with flowers growing upon foot-stalks, and the foot-stalks oval, cylindric, and crooked. 4. Aloe, with sessile, horizontal, funnel-shaped, equal flowers, turned back at the brim. 5. Aloe, with sessile, oval, crenated flowers, and the interior segments connivent. 6. Aloe, with sessile, triquetrous, two-lipped flowers, and the upper lip turned back, commonly called Cushion Aloe. 7. Aloe, with sessile, funnel-shaped, two lipped flowers, cut into five revolute segments, erect at the top. 8. Aloe, with sessile, two lipped flowers, the upper lip erect, and the under one spreading, commonly called Large Pearl-Aloe. 9. Aloe, with sessile, reflexed, imbricated, prismatic flowers. 10. The common Barbadoes Aloe. 11. The Socotrine Aloe. 12. The Cobweb Aloe. 13. The Guinea Aloe. 14. The Ceylon Aloe.

Of these species there are a vast variety, particularly of the first sort: they are all perennial plants, and natives of Africa, and the Indies—Crowfoot. In the gardens four kinds of the Ranunculus are particularly attended to, namely, the Double White—Proliferous Mountain—Golden Proliferous—and Oriental Meadow.

XIV. Four stamens; two of which are close together, and longer, as, Melittis—Honey Flower.

XV. Six stamens, four long, the two opposite short, as, Honesty—and the Stock July Flower.

XVI. The filaments of the stamens grown together into one body, as,

Hermannia—African Cranes-bill. Of this genus Linnæus distinguishes thirty-nine species; and Tournefort seventy-eight, too great a number to be inserted in this work.—Indian Vervain Mallow. 1. With angulated leaves. 2. With sinuated, hairy, many pointed leaves. 3. With spear-shaped, heart-shaped, undivided, sawed leaves, and a trailing stalk—Rose Mallow, a species of the Hollyhock. 1. With angular sinuated leaves. 2. With palmated leaves.

XVII. The filaments of the stamens grown together into two bodies, as,

Yellow Fumatory, of which there are eleven species. 1. Fumatory, with a naked stalk; or the Cucullaria. 2. Fumatory, with bilobated flowers behind, and a leafy stalk. 3. Fumatory, with a simple stalk, and bractæ as long as the flowers. 4. Fumatory, with narrow pods, growing in panicles, and an erect stalk, called Bastard Fumatory. 5. Fumatory, with narrow, four-cornered pods, and diffused stalks, with acute angles; or the Capnoides. 6. Fumatory, with three trifoliate leaves, and the small leaves heart-shaped. 7. Fumatory, with the seed vessels growing in a racemus, containing a single seed, and a diffused stalk; or the common Fumatory. 8. Fumatory, with seed-vessels growing



growing in a spike, containing one seed, an upright stalk, and filiform, or thread-like leaves. 9. Fumatory, with seed-vessels growing in a racemus, containing a single seed, and climbing leaves, with short tendrils. 10. Fumatory, with narrow pods, and leaves with clasps. 11. Fumatory, with globular, inflated pods.

The first three species are perennial plants: the first grows naturally in North America; the second in Siberia, and the third in shady and woody places throughout Europe.

The other species of this genus are annual plants. The fourth sort grows naturally in North America, and is a proper plant to grow on the sides of grottos, or rock-work, where by its continuing green all the year, and its long continuance in flower, it has a good effect.

The fifth sort is a native of France, Italy, and Mauritania, and the sixth grows naturally in rocky places in Spain and Sicily; these plants are also proper for the joints of grottos, or any rock-work.

The seventh species is a native of Europe, and particularly of this country; the eighth sort is a native of France, Spain, and Italy.

The ninth species is a native of France and England; and the tenth is also a native of rocky places in England. The eleventh sort grows naturally at the Cape of Good Hope—Milkwort. Linnæus distinguishes no less than twenty-two species of this plant, but the three following only are to be met with in our English gardens. 1. Milkwort, with crested flowers, a moon-shaped keel, and a shrubby stalk, having oblong leaves, which end in obtuse petals. 2. With flowers growing thinly, and without beards; the point of the keel roundish, a shrubby stalk, and spear-shaped leaves. 3. With spiked flowers, without beards, an erect, single, herbaceous stalk, and broad spear-shaped leaves—Everlasting-pea.

XVIII. The filaments of the stamens grown together, into three or more bodies, as, 1. Theobroma—Orange. 1. The common Seville. 2. The China. 3. The Willow leaved, or Turkey. 4. The Pampelmoes, or Shaddock. 5. The Dwarf or Nutmeg.—St. John's-wort.

XIX. The stamens, and anthera's grown together in form of a cylinder. These have rarely filaments, as, 1. Dandelion. 2. Xeranthemum—Sun-Flower, of which there are ten species. 1. Sun-flower, with all the leaves heart-shaped, veins uniting behind at the base, but towards the border naked; commonly called Annual Sun-flower. 2. Sun-flower, with the under leaves heart-shaped, veins uniting behind at their base, and the upper leaves oval; commonly called Perennial Sun-flower. 3. Sun-flower, with oval, heart-shaped leaves, with the nerves uniting in the leaf; commonly called Jerusalem Artichoke. 4. Sun-flower, with a stalk smooth on the under side, heart-spear-shaped leaves, and a ten petals in the rays. 5. Sun-flower, with a spindle-shaped root. 6. Sun-flower, with rough, spear-shaped leaves, and a slender stalk, smooth towards the bottom. 7. Sun-flower, with smooth, spear-shaped, sawed leaves. 8. Sun-flower, with narrow leaves. 9. Sun-flower, with oblong, opposite, oval, sessile leaves, three veins, and a dichotomous panicle. 10. Sun-flower, with oval, rough, crenated leaves, with three nerves, the seeds of the cup erect, and as long as the disk of the flower.

All these species are natives of different parts of America. The second sort is most proper for large borders in great gardens; it begins flowering in July, and continues till October.

The Marigold, of which there are seven species. 1. Marigold, with narrow, spear-shaped leaves, and prickly seeds, or the least Marigold. 2. Marigold, with boat-shaped, prickly seeds in the border, and those in the center bicombed. 3. Marigold, with spear-shaped, indented leaves, and slender foot-stalks. 4. Marigold, with sinuated, indented, spear-shaped leaves, and a naked stalk. 5. Marigold, with indented, spear-shaped leaves, and the upper part of the foot-stalk swelling. 6. Marigold, with narrow, entire leaves, and a naked stalk. 7. Marigold, with obverse, oval leaves, which are indented, and a perennial shrubby stalk.—Globe Thistle. 1. The Greater. 2. The Smaller. 3. With a large head. 4. With a small blue head.

The first species is a native of Italy and Spain; the second of France and Italy; the third of Spain; and the fourth of Greece—Cardinal-Flower, a genus of plants, of which there are ten species. 1. Cardinal-Flower, with an erect stalk, spear-shaped, sawed leaves, and a spike of flowers, terminating the stalk, commonly called Scarlet Cardinal-Flower. 2. Cardinal-Flower, with an erect stalk, linear, spear-shaped, entire, acute-pointed leaves, and a spike of flowers terminating the stalk. 3. Cardinal-Flower, with an erect stalk, oval, spear-shaped, crenated leaves, and the sinuses of the im- palements reflexed; commonly called the Blue Cardinal-Flower. 4. Cardinal-Flower, with an erect stalk, heart-shaped leaves, which are somewhat indented, having foot-stalks, and the longest spike of flowers, which are placed thinly. 5. Cardinal-Flower, with an erect stalk, the lower leaves roundish and crenated; the upper spear-shaped, sawed, and a spike of flowers terminating the stalk. 6. Cardinal-Flower, with an erect stalk, oval leaves, which are somewhat sawed, longer than the foot-stalk, and swelling seed-vessels. 7. Cardinal-Flower, with oval, crenated leaves, which are downy, and flowers growing singly from the sides of the stalk. 8. Cardinal-Flower, with spear-shaped, indented leaves, very short foot-stalks to the flowers, which proceed from the sides of the stalks, and a very long tube to the petal. 9. Cardinal-Flower, with a spreading, branching stalk, spear-shaped leaves, which are somewhat indented, and very long foot-stalks to the flowers. 10. Cardinal-Flower, with trailing stalks, spear-shaped, sawed leaves, and foot-stalks proceeding from their sides.

The varieties are natives, or grow naturally in North America, at Campeachy, Virginia, Jamaica, Blois in France, and at the Cape of Good Hope. The third sort has a perennial fibrous root; the fourth is an annual; the sixth and seventh are biennial plants.

XX. The stamens inserted on the pistil; but not on the receptacle, such as, 1. Orchis—Sisyrinchium, Bermudiana—Passion-Flower. Of this genus of plants are no less than twenty four species mentioned by Linnæus; a particular description of all which would be needless, as they bear a great resemblance to each other; one, the most beautiful is the Laurel-leaved Passion-Flower, a native of South America.—Birthwort—and Cuckow Pint.

XXI. Male and female flowers on the same plant, such as, 1. Triple-headed Pond Weed—Tripsicum—Roman Nettle—Parthenium—Walnut—Scotch Fir—Male Balsam Apple—Bastard Orpine, a native of France.

XXII. The male flowers on a different plant from the female, as, 1. The Hop—White Mistleto—Crow-berries—Brown Willow—Dogs Mercury—Black Poplar—Bryony



Bryony, Cliftoria, Moon-feed, Kiggelaria, Pulchella, Butcher's Broom, Juniper. These plants are all in the class of *Epiphytes*, or plants which grow upon other plants, and are not rooted in the ground. *XXIII.* Hermaprodites, or male and female flowers on the same plant, such as the Common Fig, Flowering Asphodel, White Hellebore, &c. *XXIV.* Flowers within the fruit, or imperceptible to the eye, as the *Polypodium*, *Bryonia* (matted), *Fucus*, *Agaric* (field). Such is the *Linnean System* of the different genera, and orders of flowers; to which we have added two plates, and half a one, under the title of leaves, wherein are distinguished by Linnaeus, the cups and other parts of flowers, (as sexes, &c.) ranged under their different orders, as *Monogynia*, *Digynia*, *Monandria*, *Diandria*, &c. &c. We proceed now to

**TOURNEFORT'S SYSTEM OF FLOWERS.**

In this the genera, or different kinds of plants are included in twenty-two classes; to which is prefixed general and classical characters of flowers. It is unnecessary to enter upon the particular plants, trees, shrubs, flowers, &c. enumerated under each class in this system, since most of them have been described either in the former one, or in the *Natural History of Vegetables*, page 296; and to find the latter, the reader has only to consult the Index under the head of Botany. To these we have added a Plate of the *Abutilon*, with leaves resembling those of a red gooseberry-tree; having a flesh-coloured flower, and fruit of a pentagonal, or five cornered shape, and rough-tasted; and the *Hairy Abutilon* of the shrub kind, with a roundish leaf, a large and spreading flower of a pale colour, and a single cup and calix. We have likewise given another plate of various objects in Natural History, as Feathers, Death Watch, Fibres, Plants, Water Spout, Seed, &c.

**LEAVES.**

**B**OTANISTS consider the leaves with regard to their structure, surface, shape, consistence, edges, situation, and size; with regard to their structure, they are either single, as those of the apple, pear, and plum-tree, or compound, as those of the strawberry, parsley, &c. a single leaf is one which is either immediately joined to the branch, or connected with it by a foot-stalk; a leaf is said to be compound, when there are more than one upon a petiole or foot-stalk: with respect to their surface, they are either flat, as the *origanum*, or in bunches, as the *houseleek*: with regard to their shape, they are either lanceolated, cordated, acuminate, hastate, &c. and are either thin and fine, as those of the *hypericum*; or thick and gross, as those of the *purslane*; or fleshy, as those of several kinds of *aloes*; or woolly, as those of *marsh-mallows*: with regard to their edges, leaves are cut slightly, as in some species of *geums*, or deep, as in some of the *centaureas*; with respect to their situation, they are either ranged alternately, as the *alaternus*; or opposite to each other, as the *phillyrea*, *mint*, *baum*, &c. with regard to their size, they are either very large, as those of the *musa*; or moderate, as those of the *fig* and *vine*; or small, as those of the *elm* or *apple tree*; or very small, as those of the *heath*, *phylica*, &c. See the Plate of Leaves.

Many sorts of plants, whose roots shoot forth from the small end of the seed, put out two small leaves that are very unlike those which the plant

afterwards produceth; for as soon as the root has taken hold of the ground, between these false leaves (commonly called the seed-leaves) there comes forth a shoot which produces leaves like those of the mother plant; of this manner of growth there is an infinite number of plants.

Dr. Grew observes, that the fibres of leaves consist of two general kinds of vessels, viz. for sap and for air: and are ramified out of greater into less, as veins and arteries are in animals.

Mr. Frederick of Augsbourg, a celebrated gardener, took from the tree a leaf of the *opuntia* or *Indian fig-tree*, and setting it in the earth, it immediately took root, and produced blossoms and fruit.

The distinction of leaves, made by those who have written on botany, are the following:

A simple leaf is that which is not divided to the middle.

A compound leaf is divided into several parts, each resembling a simple leaf, as in *liquorice*, &c.

A digitated leaf is a compound leaf, divided into several parts, all of which meet together at the tail, as in the *hemp*, *black hellebore*, &c.

A trifoliated leaf is a digitated leaf, consisting of three fingers, as the *trefoil*, &c.

A quinquefoliated leaf is a digitated leaf, consisting of five fingers, as in the *quinquefolium*.

A pennated leaf is a compound leaf divided into several parts, each of which is called a lobe, placed along the middle rib, either alternately, or by pairs. When the middle rib is terminated by an odd lobe, it is said to be unequally pennated, as in the *goats-rue*, &c. and equally pennated, when it is not terminated by an odd lobe, as in the *cassia*; when the lobes are all nearly of the same form and bigness, it is called an uniform pennated leaf, as in the *liquorice*; when they are not so, it is said to be difform, as in the *agrimonia*.

A winged leaf is, as it were, divided into several pennated leaves, as in the *orobus*, &c.

A ramose leaf is that which is still farther divided than the winged leaf, as in the *osmund royal*, *female fern*, &c.

An entire leaf, or lobe is that which has no division on its edges, as in the *apple-tree*, &c.

A sinuated leaf is that which is cut about the edges into several long segments, as in the *common mallows*.

A serrated leaf is that which is cut about the edges into several acute segments, resembling the teeth of a saw, as in the *nettle*, &c.

An obtusated leaf is that which is cut about the edges into several obtuse segments, as in the *beetroot*, &c.

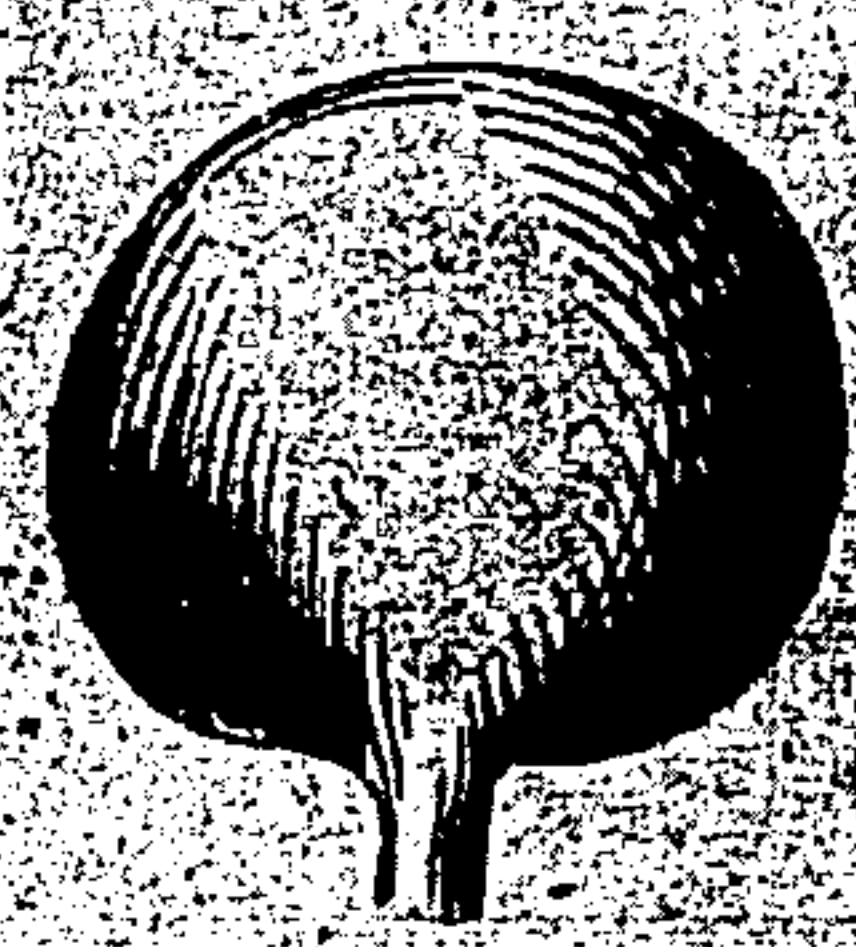
A laciniated or jagged leaf is that which is cut about the edges into several pretty deep portions, in an irregular manner, as in the *thorned poppy*, &c.

If the surface of the leaves are altered, by reversing the branches of the trees on which they grow, the plants are stopped in their growth, until the foot-stalks are turned, and the leaves recover their former position. This shews how necessary it is to support all those weak shoots of plants, which are naturally disposed for upright growth; which neither twine about the neighbouring trees for support, nor that put out claspers, by which they take hold of whatever trees or plants grow near them, and are thereby supported; and, on the contrary, how absurd is that practice of tying up the shoots of those plants which are naturally disposed to trail upon the ground, for in both these cases nature is reversed, and consequently the growth of both sorts of plants is greatly retarded.

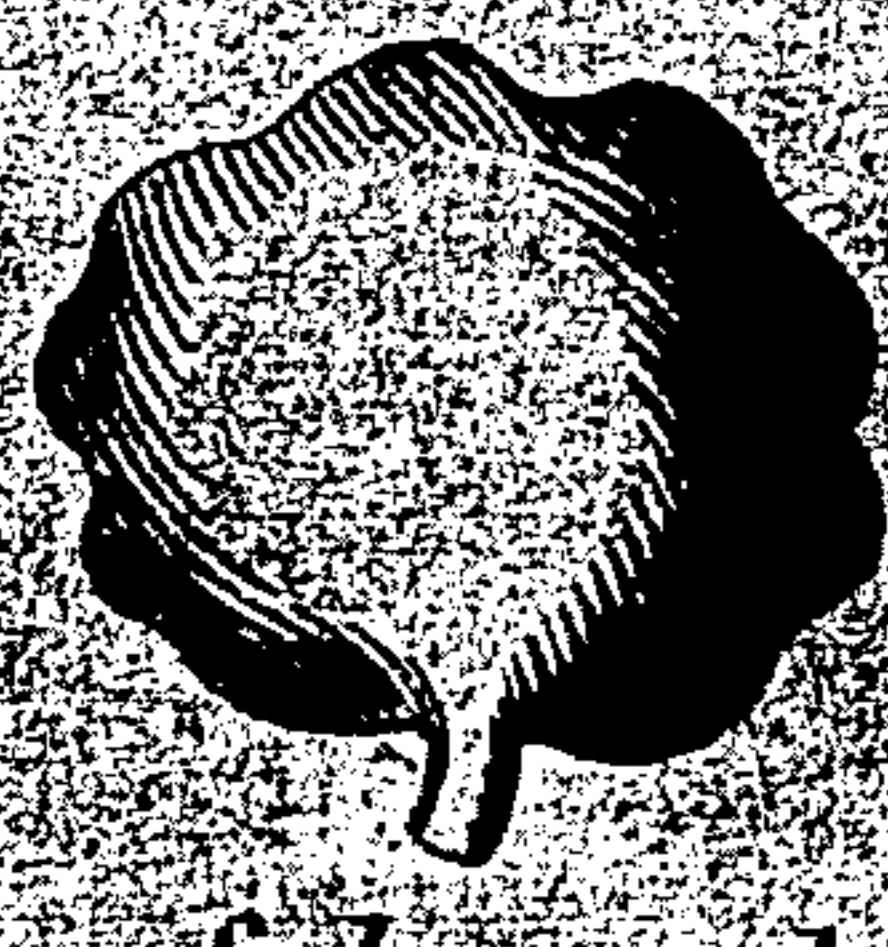
This is one of the great functions for which the leaves of trees and plants are designed; but, besides this,



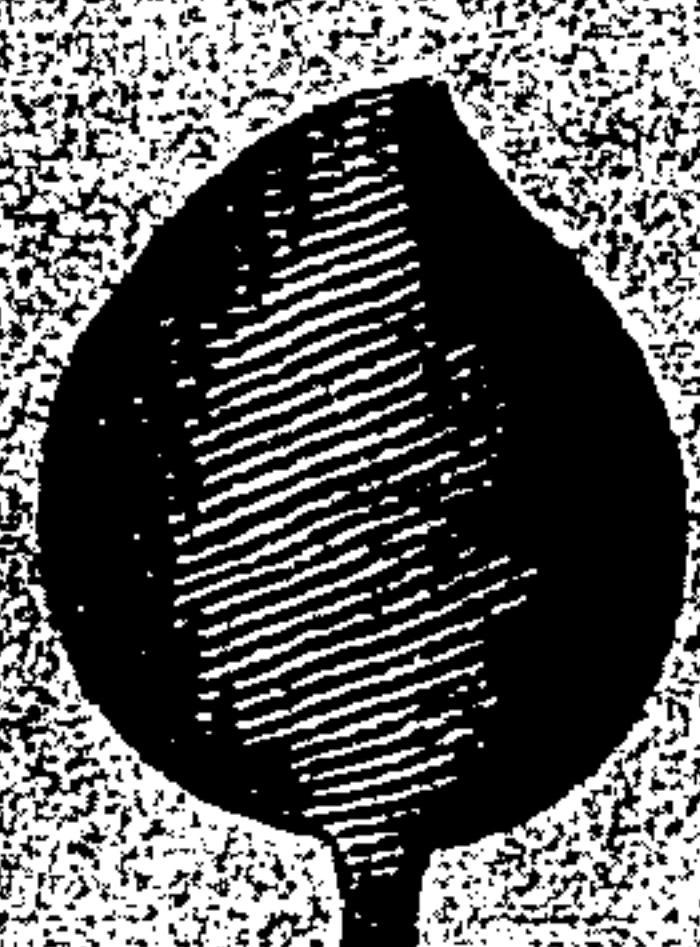
# LEAVES.



Orbiculate



Subrotund



Ovate



Oval



Oblong



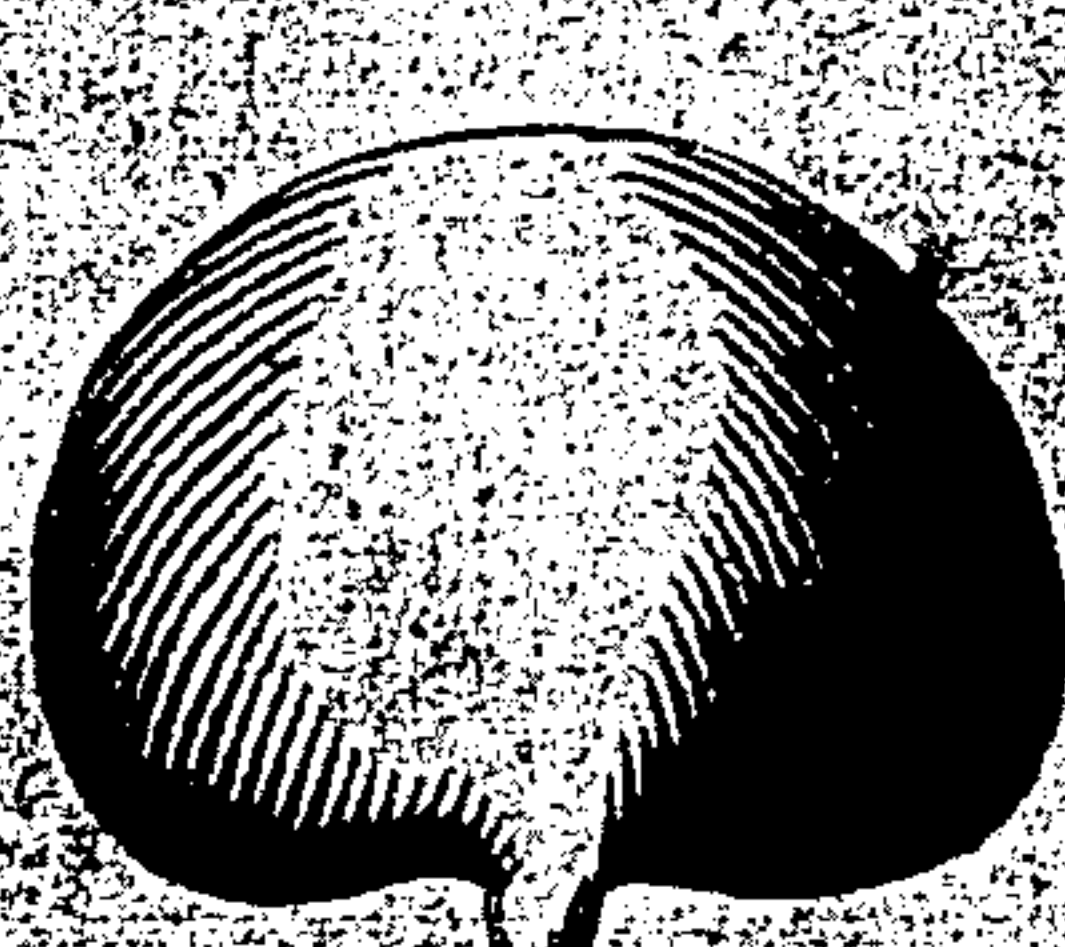
Lanceolate



Linear



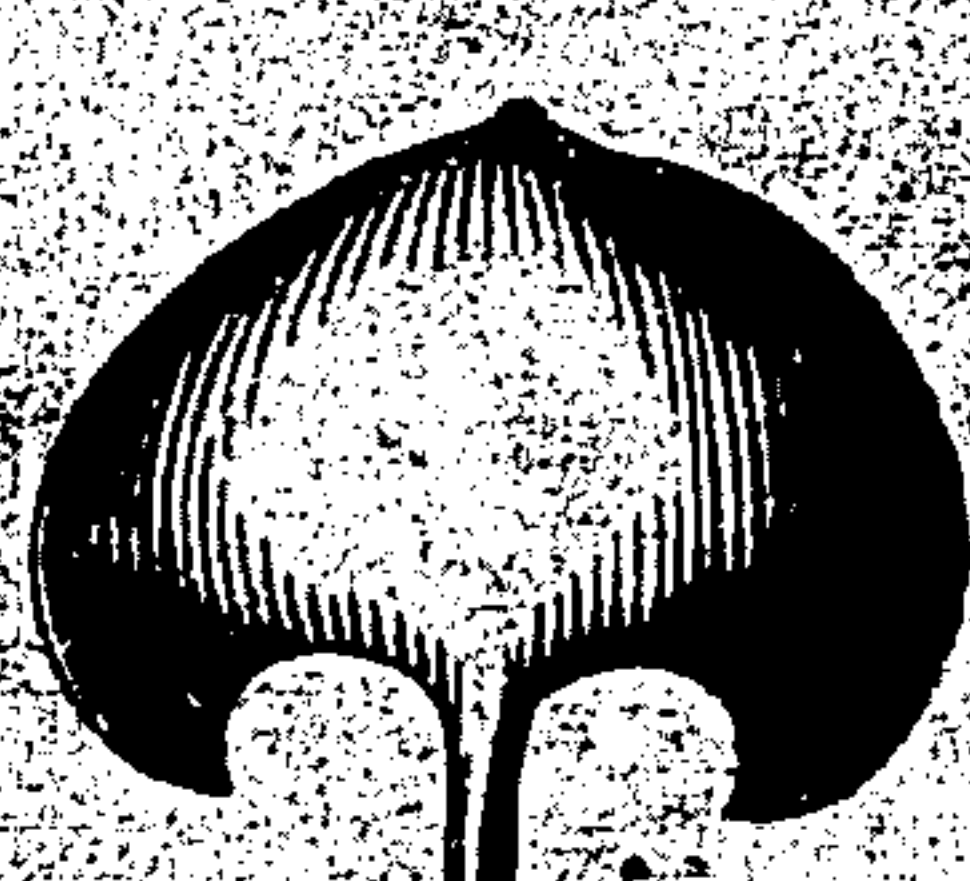
Subulate



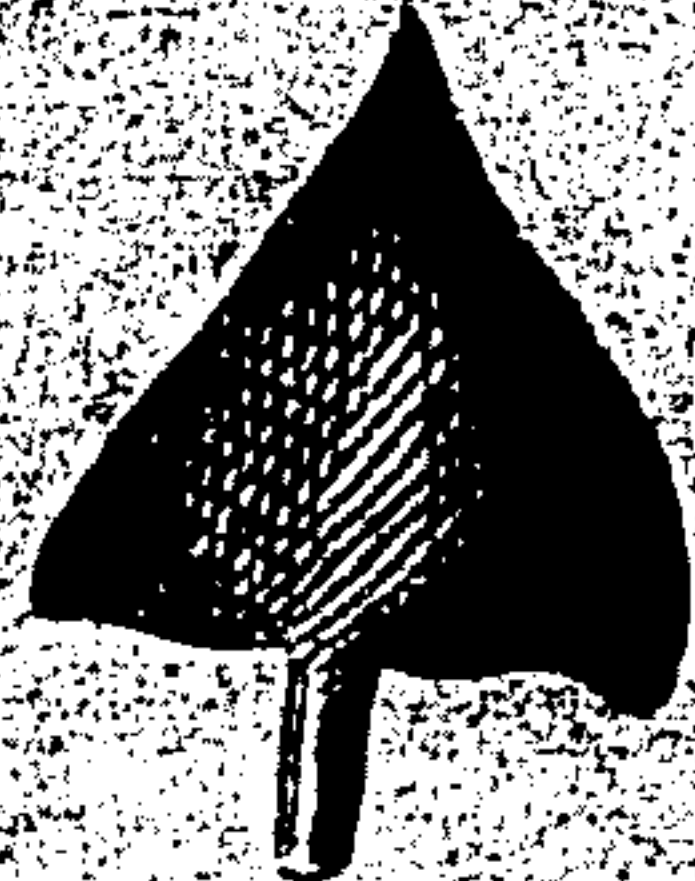
Reniform



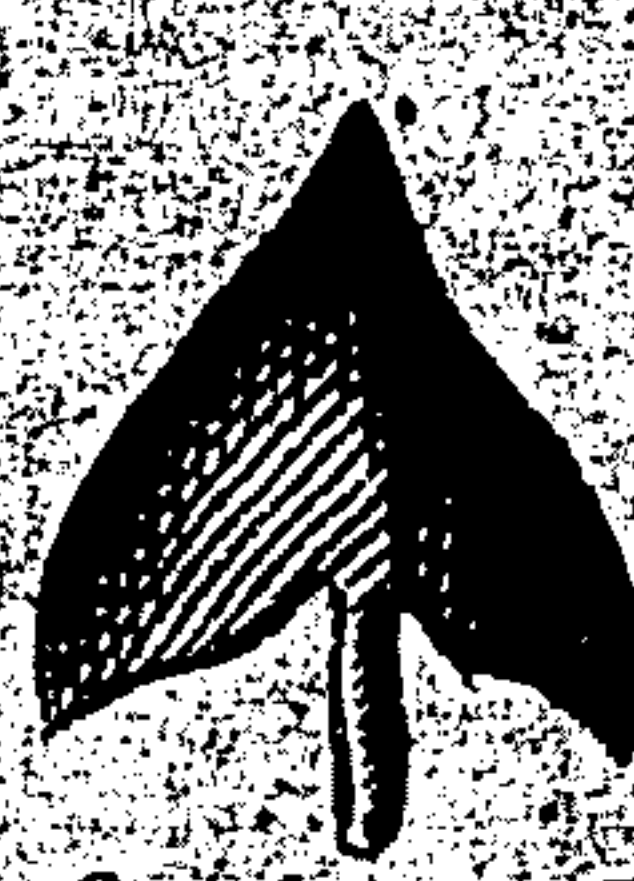
Cordate



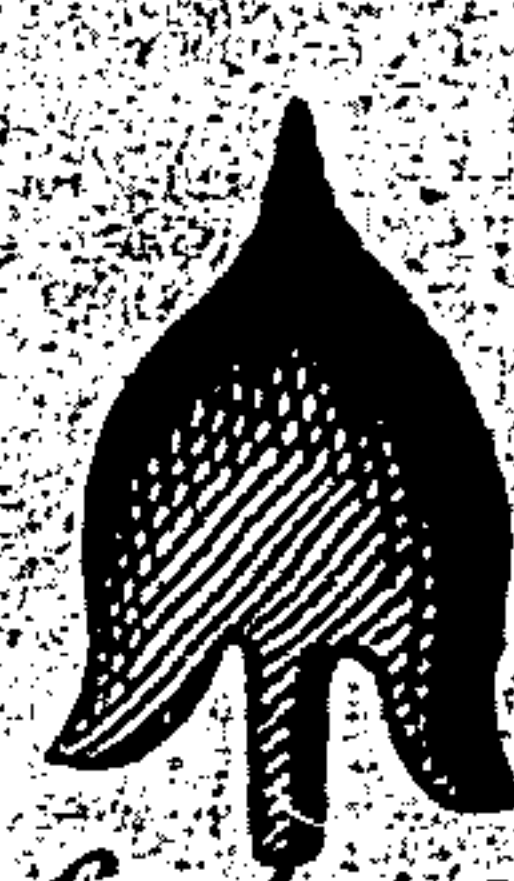
Lunulate



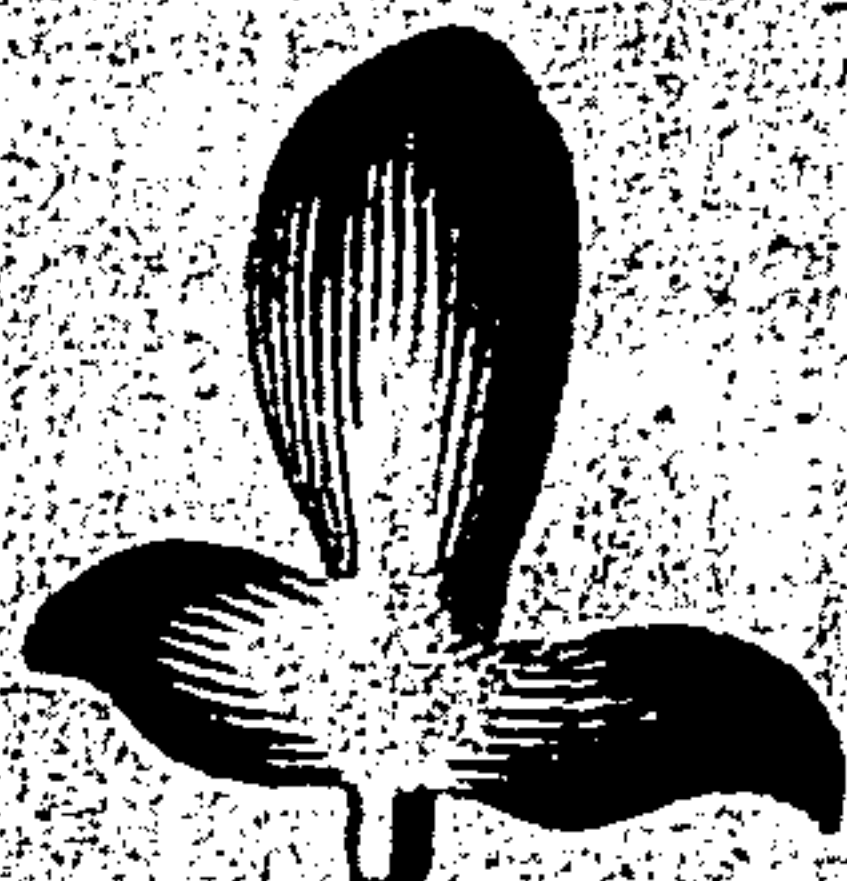
Triangular



Sagittate



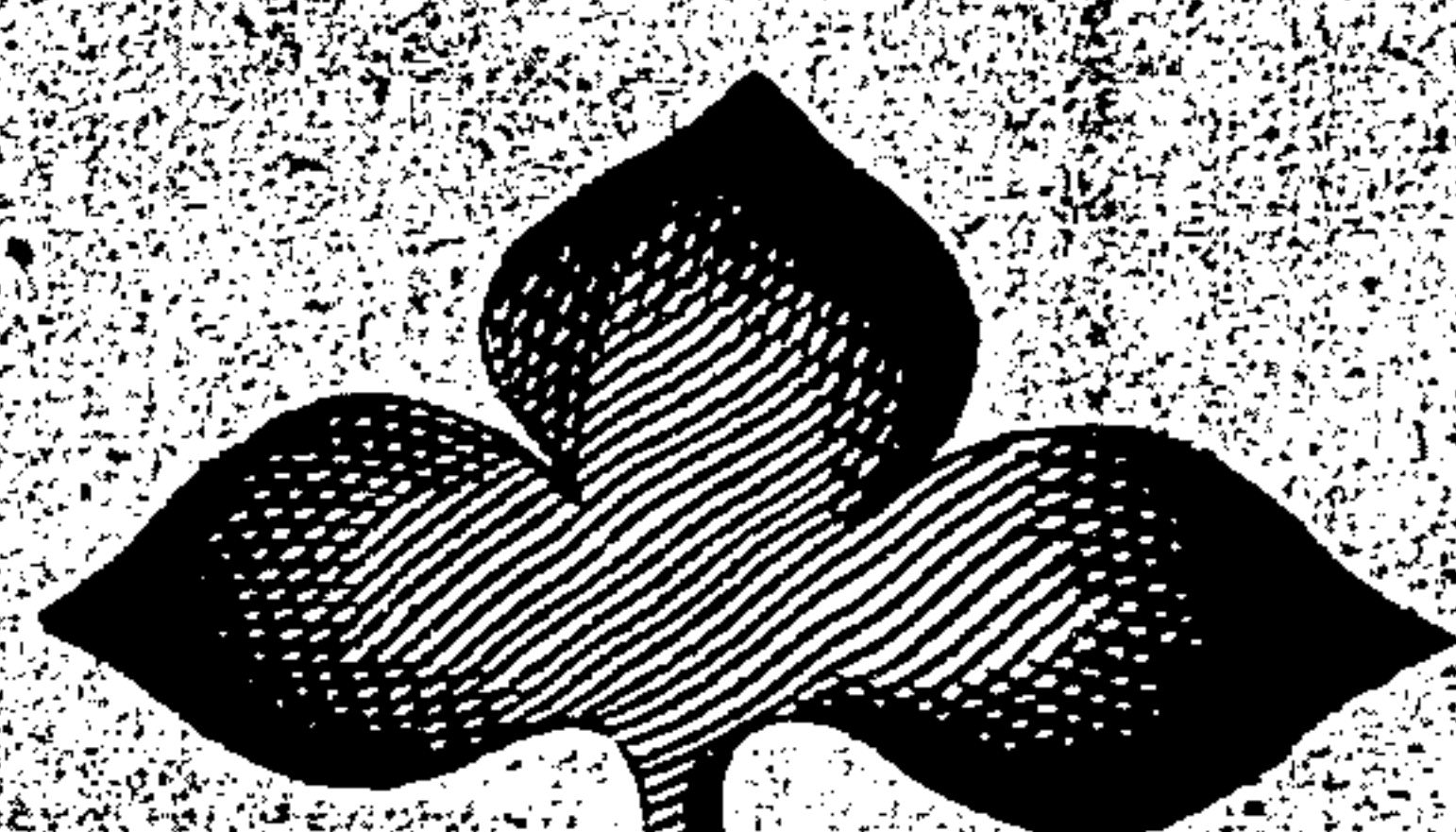
Cordato-sagittate



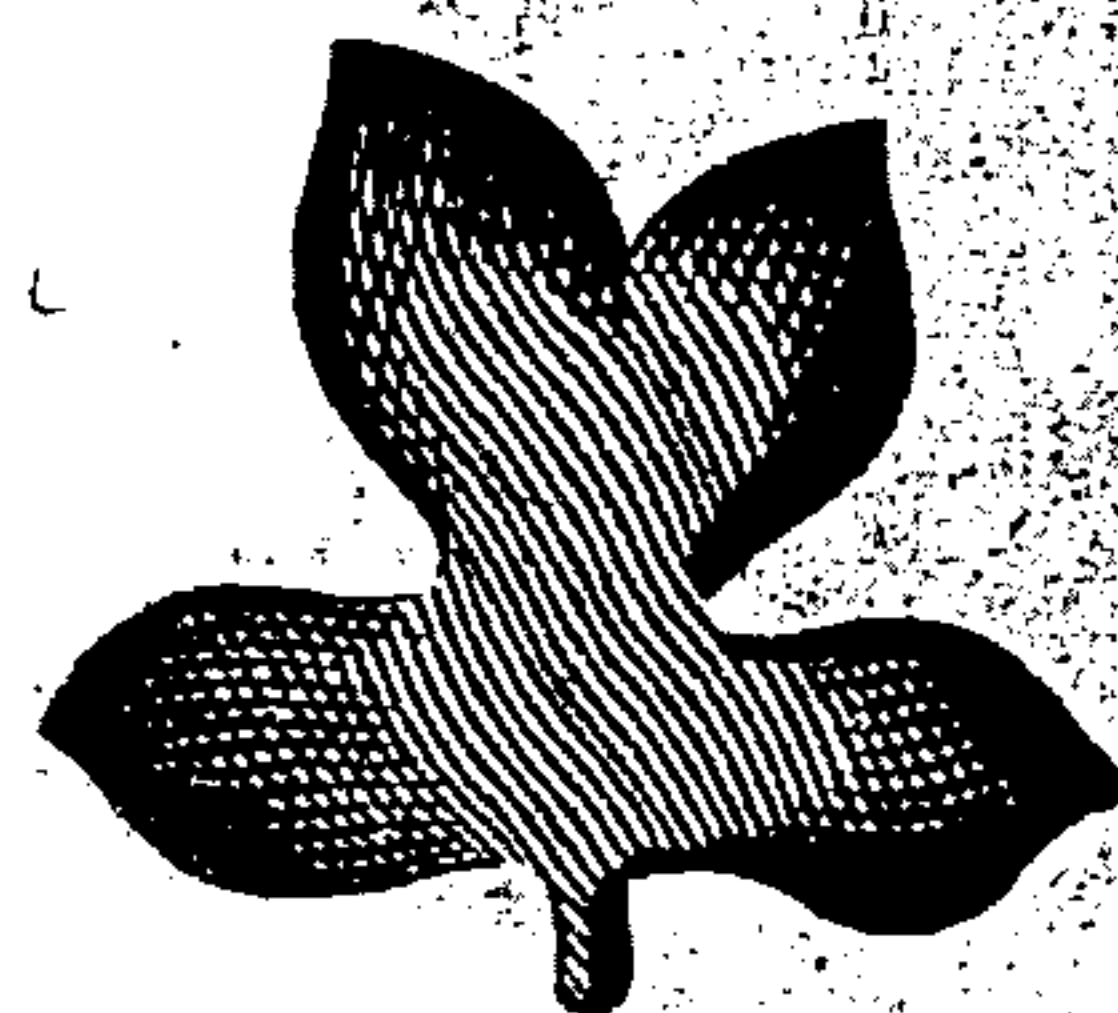
Hastate



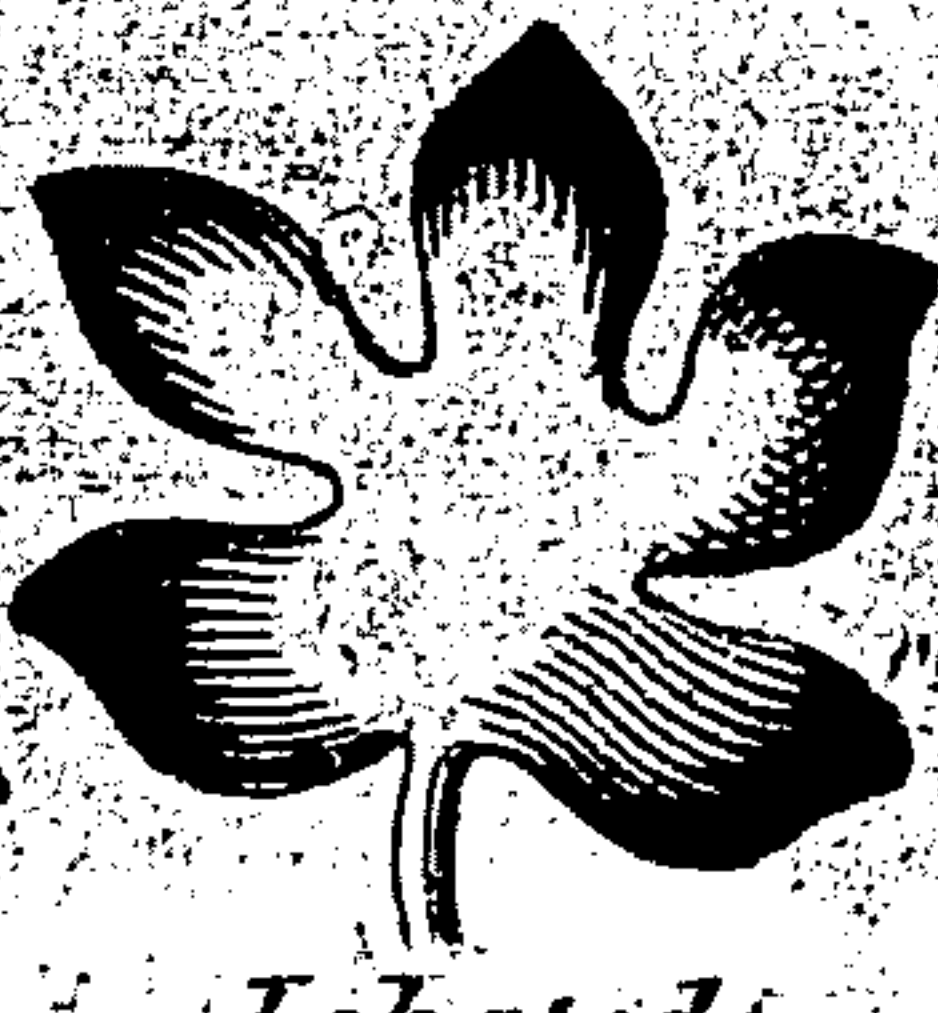
Obversely-cordate



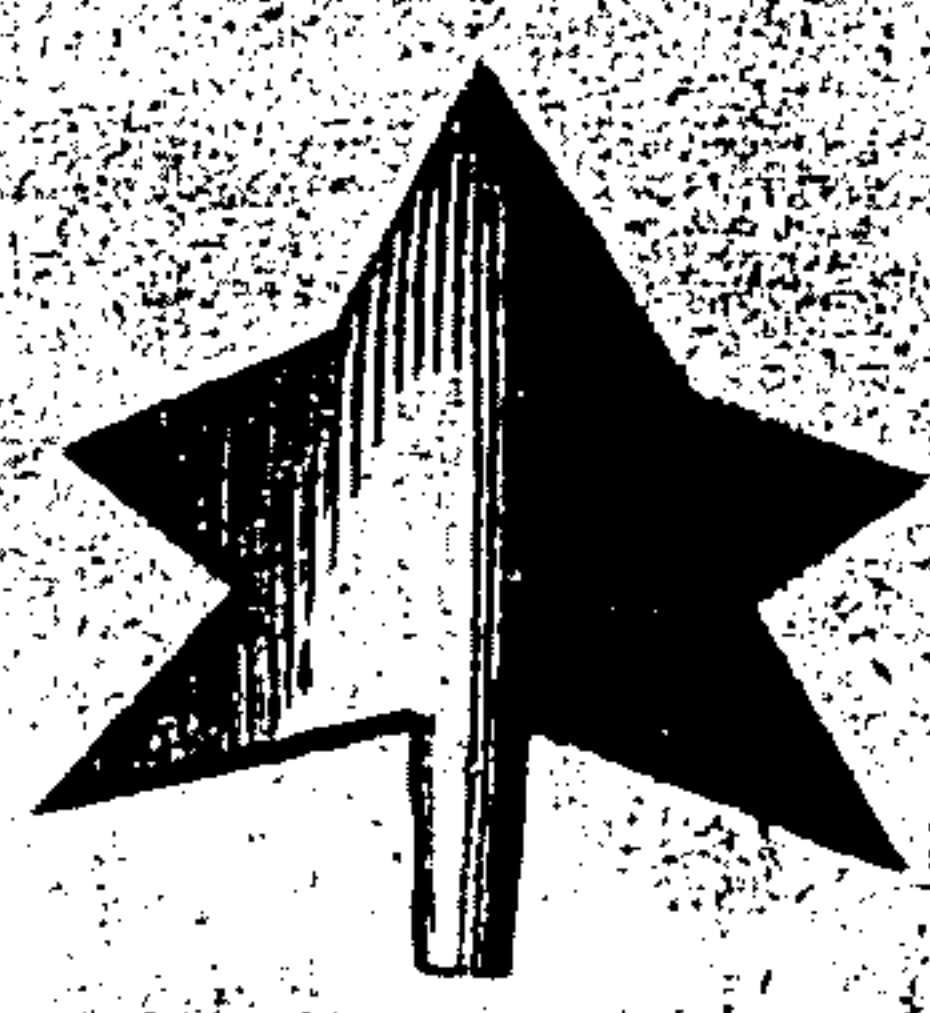
Trilobate



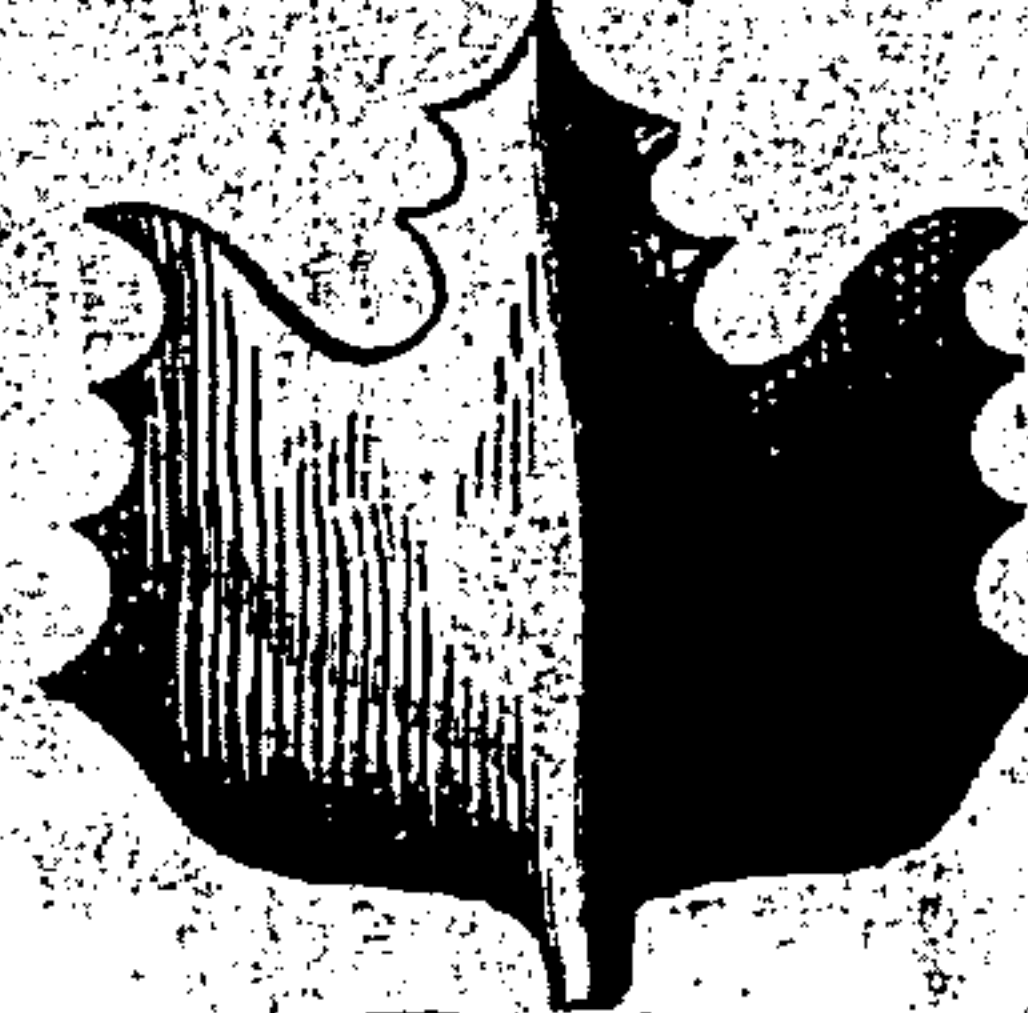
Præmorse



Lobate



Quinquangular



Eroded



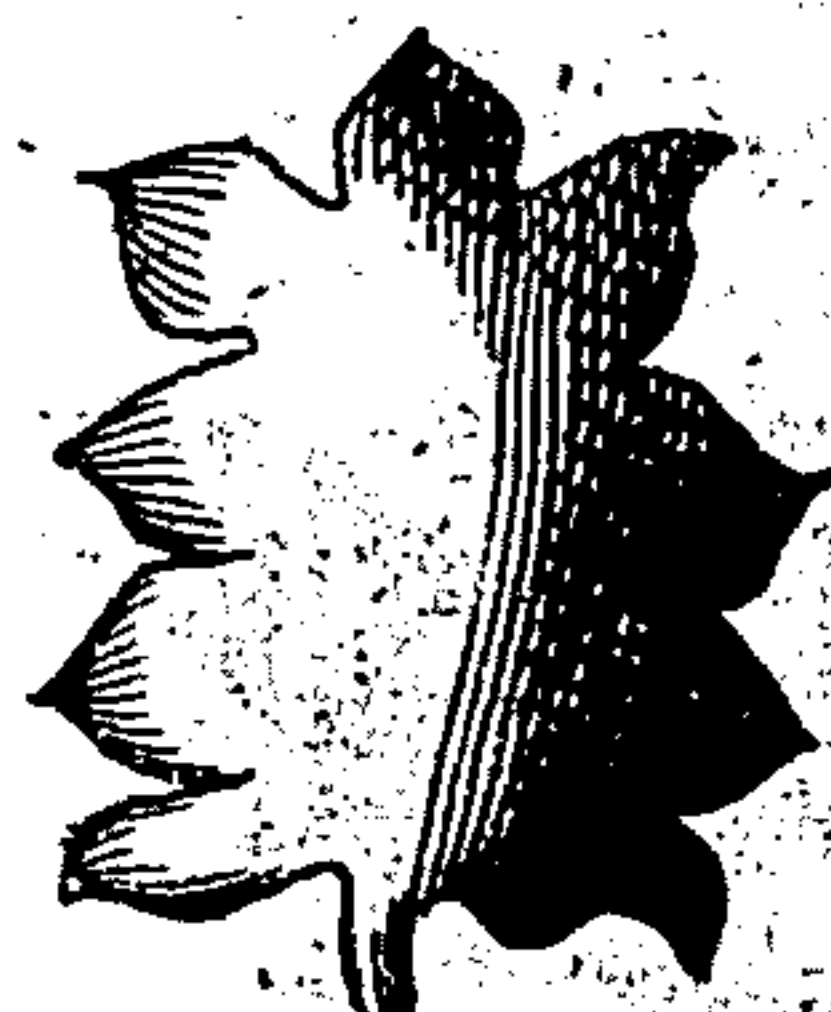
Palmated



Pinnatifid



Laciniate



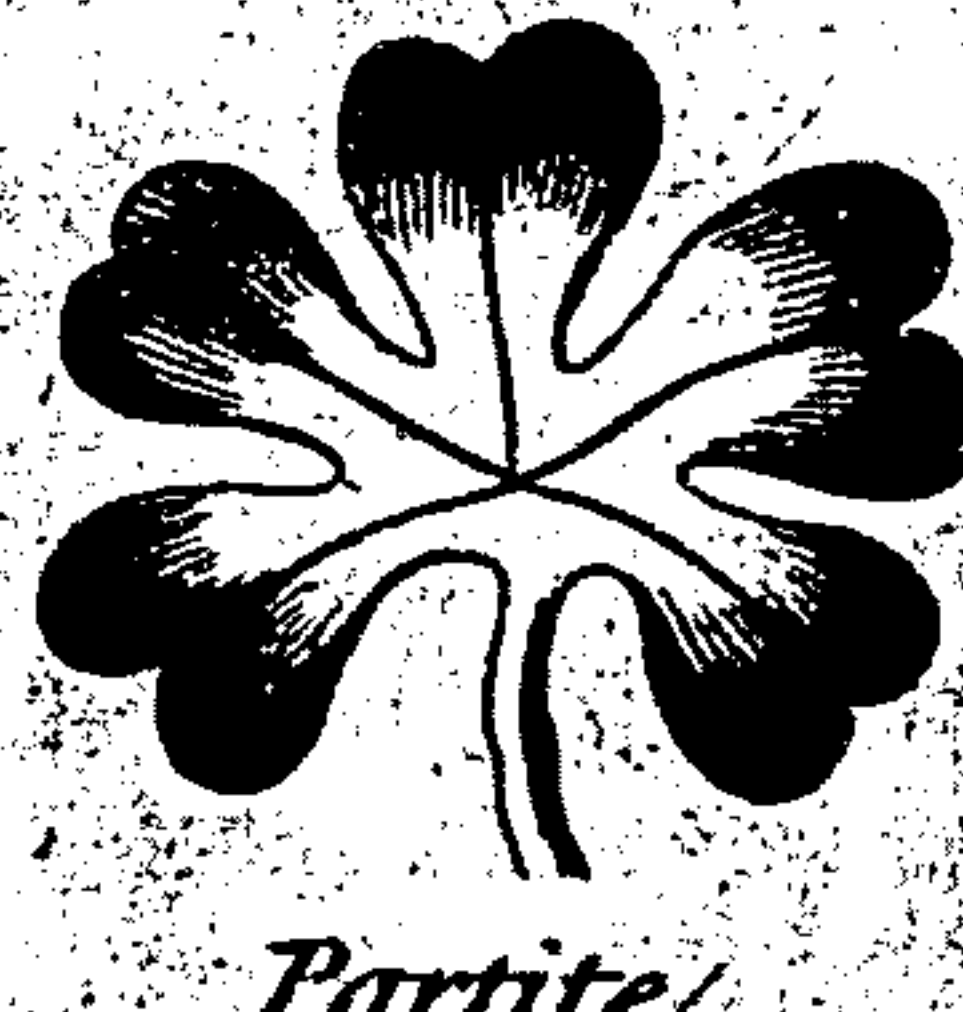
Sinuate



Dentato-sinuate



Retrorso-sinuate



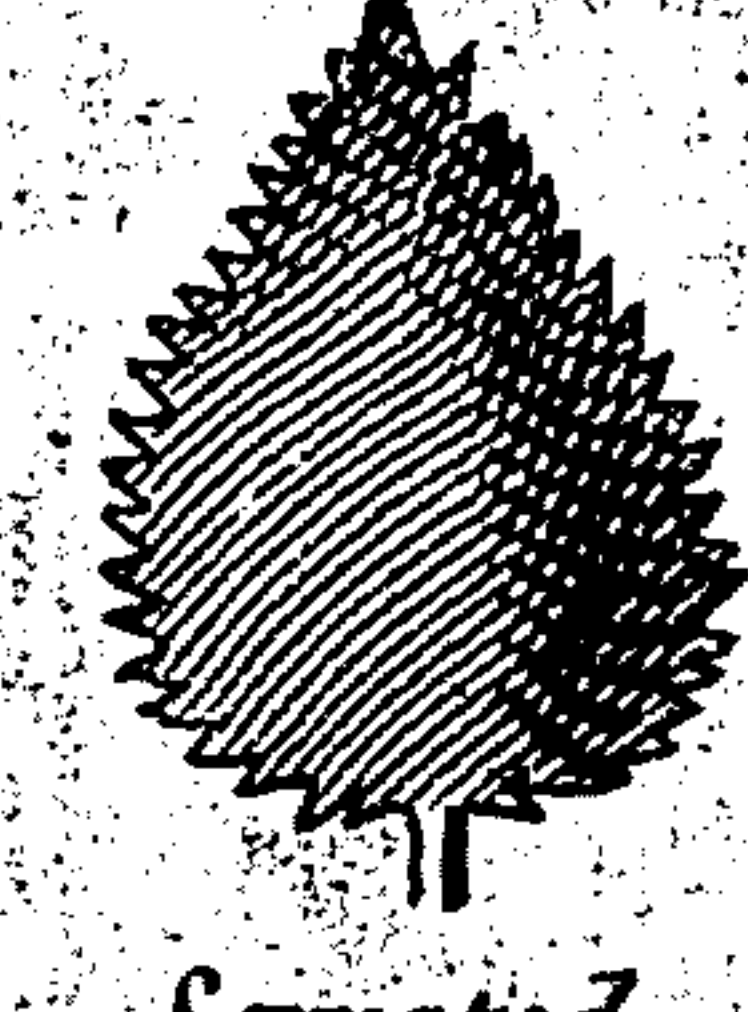
Partite



Repandous



Dentated



Serrated



Duplicately-serrated



Duplicately-crenate



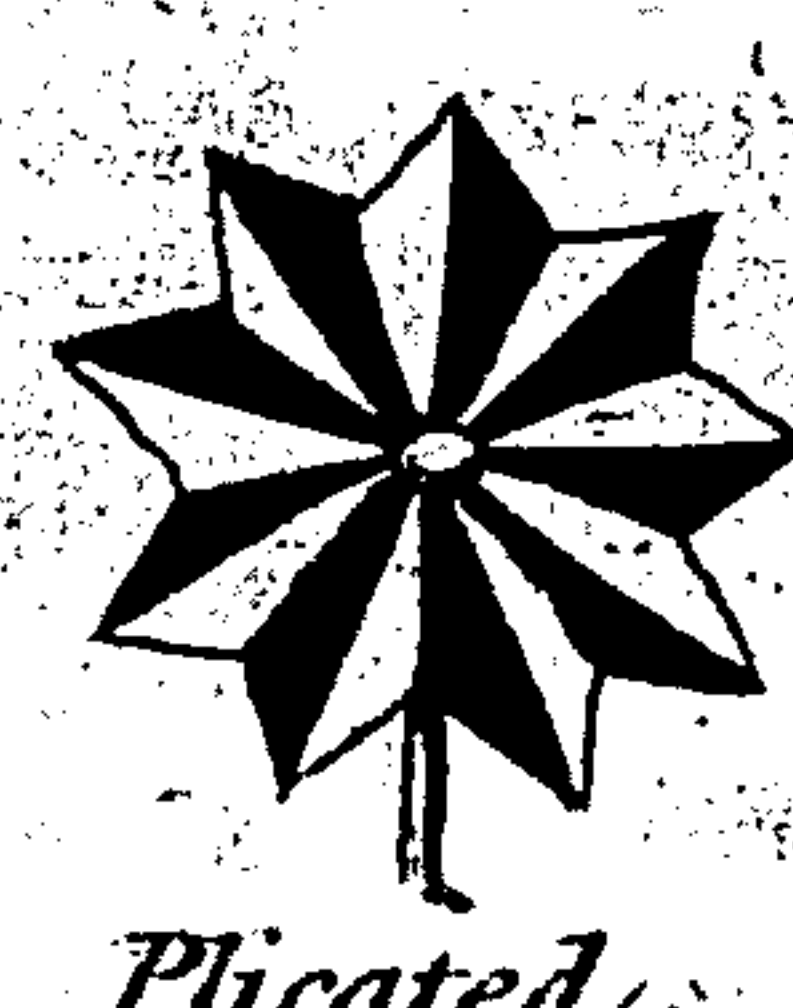
Cartilaginous



Acute ly-crenate



Obtusely-crenate



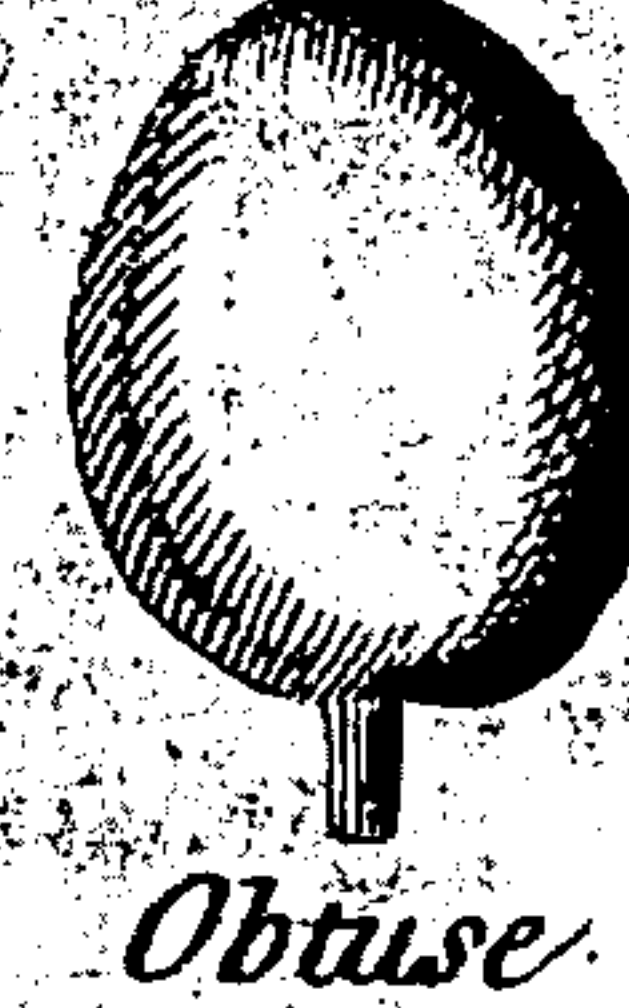
Plicate



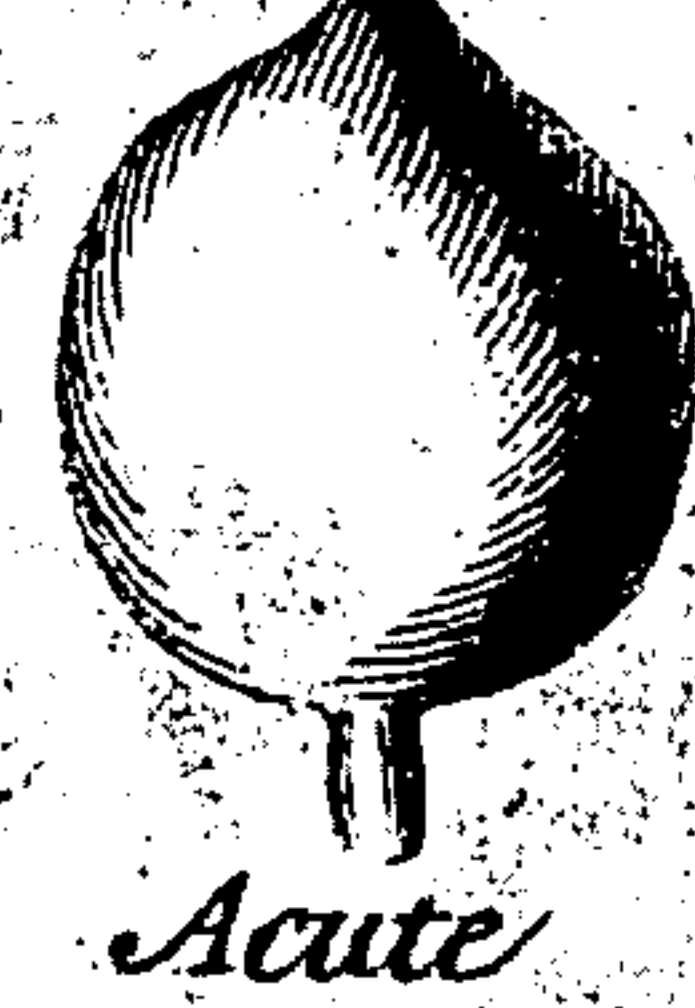
Crenate



Curl'd



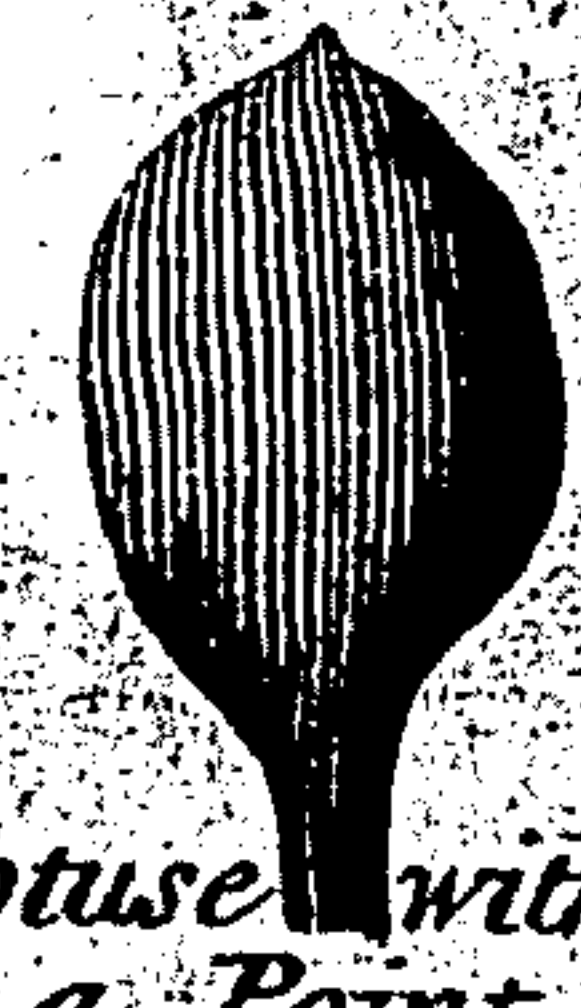
Obtuse



Acute



Acuminate



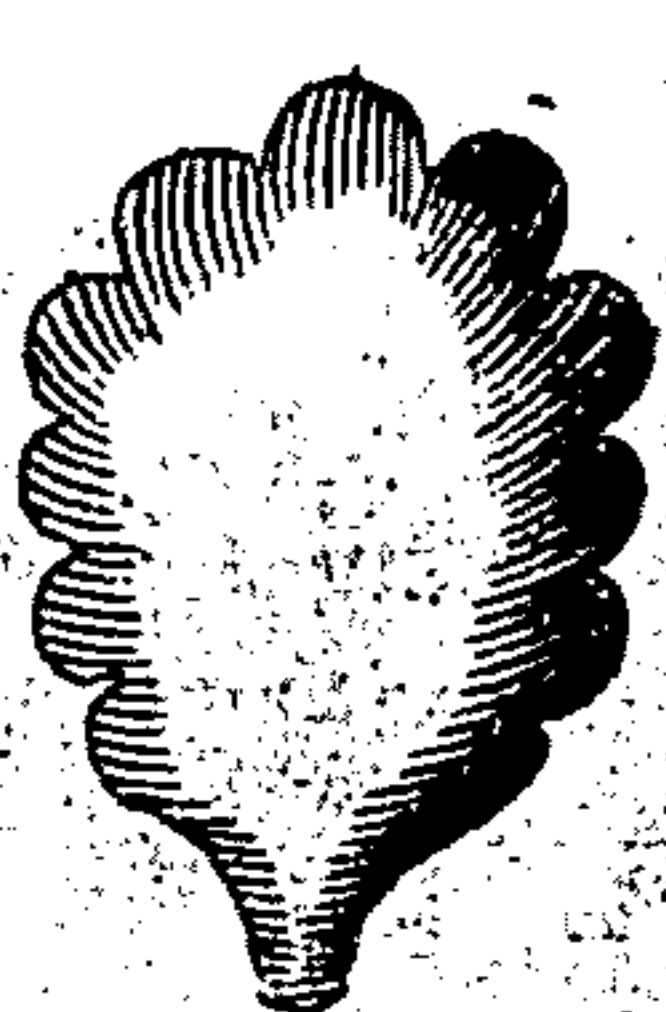
Obtuse with a Point



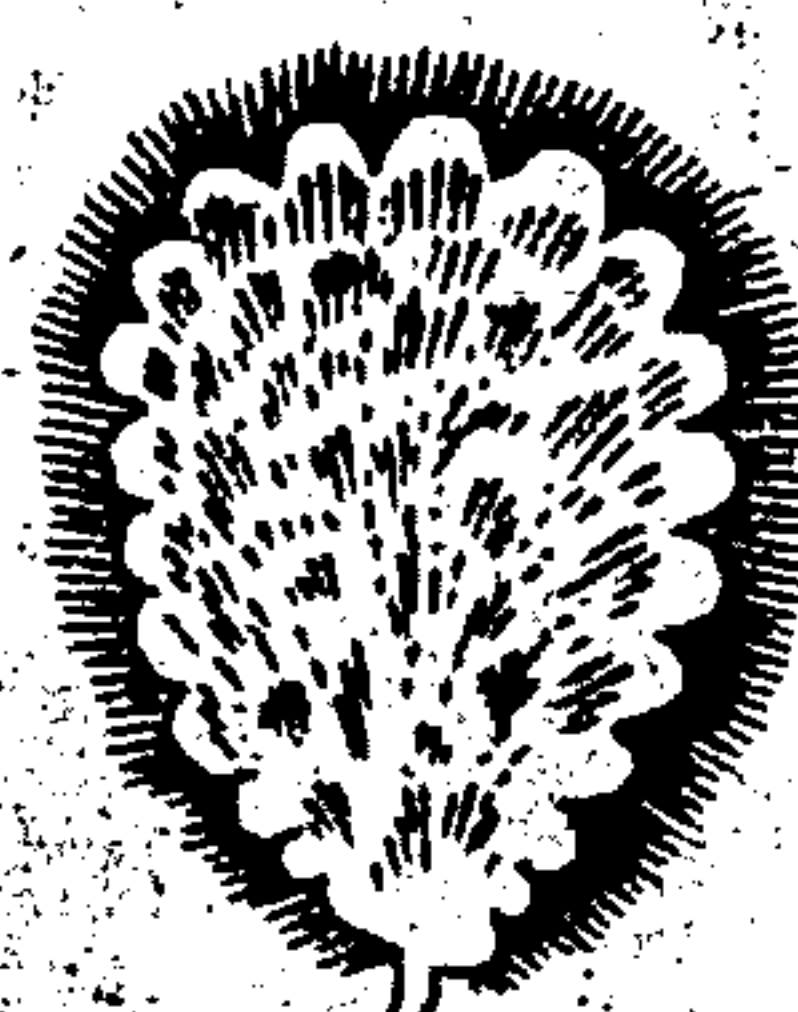
Acute and Emarginate



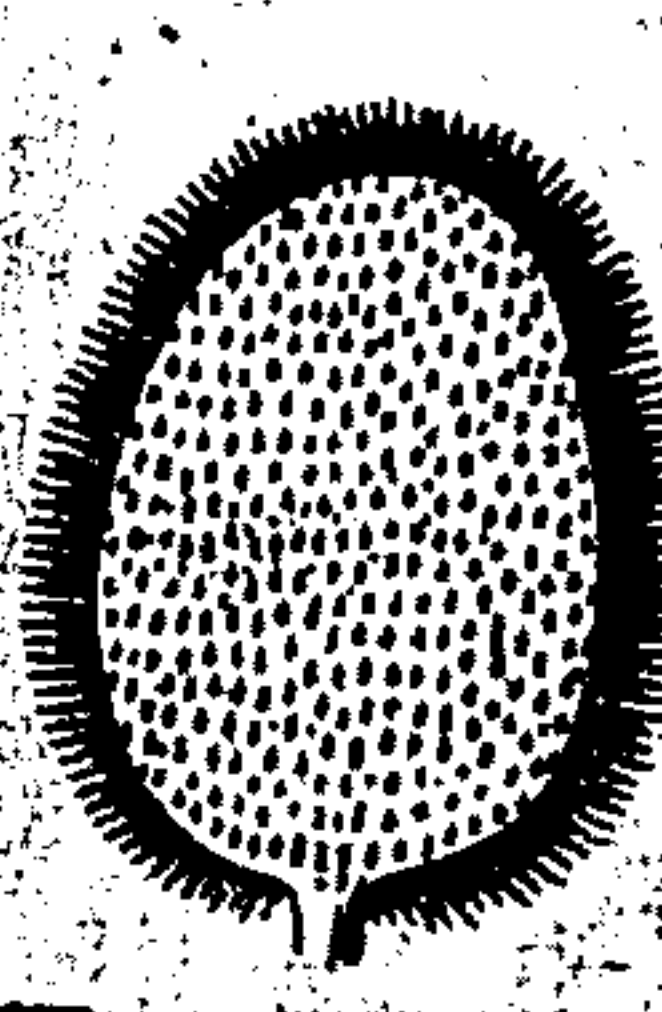
Guneiform and Emarginate



Retuse



Pilose



Tomentose



Hispid



Ghated



Rugose



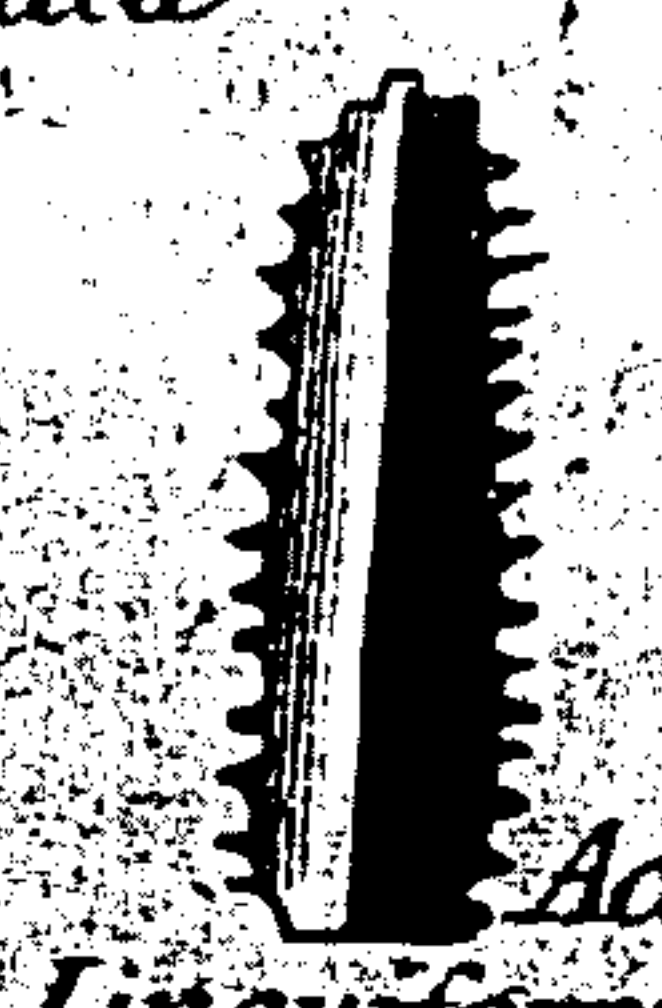
Venous



Nervous



Papillous



Linguiform



Acinaciform



Dolabriform



Deltoide



Triquetrous



Canaliculated



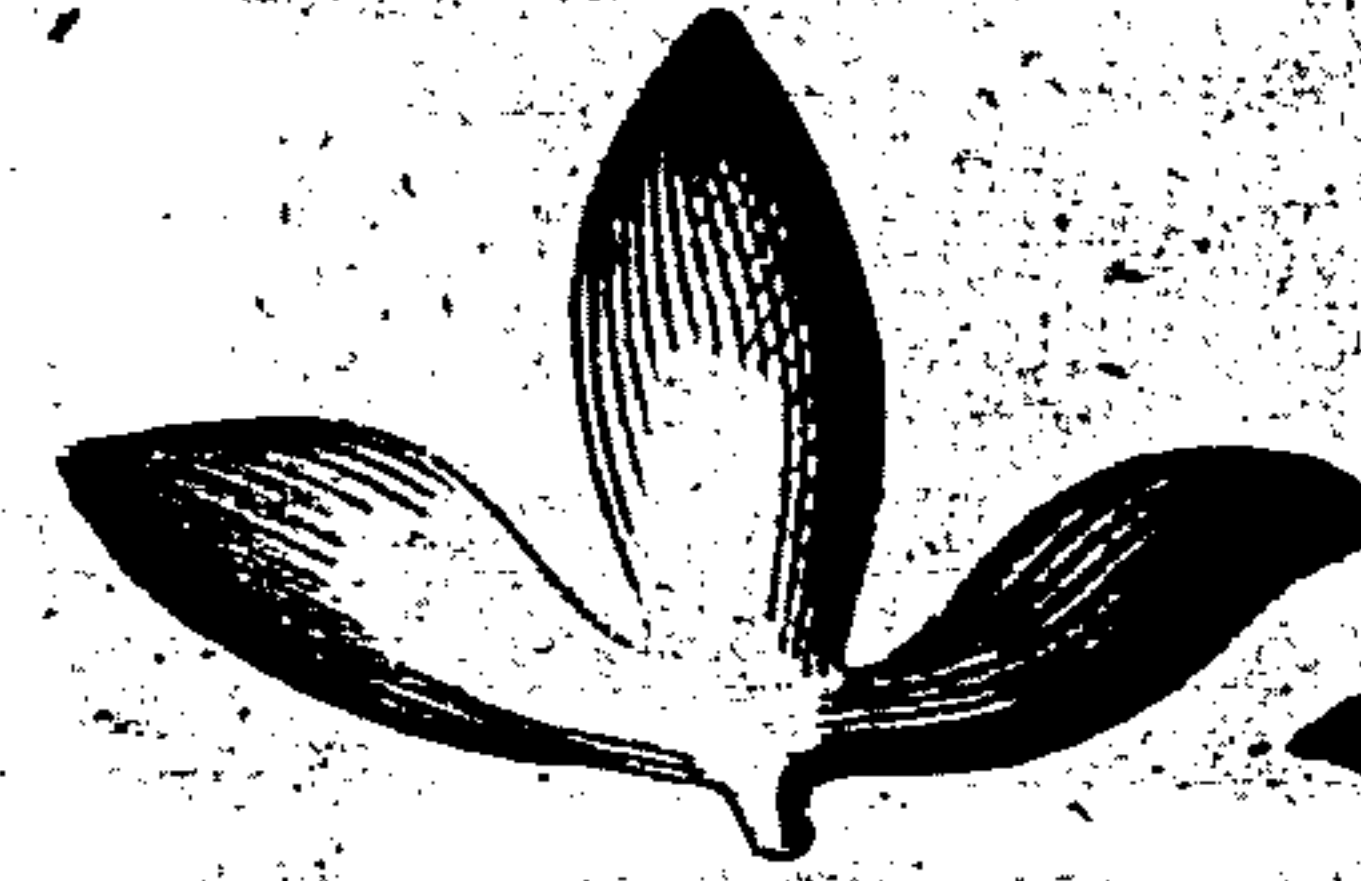
Rounded



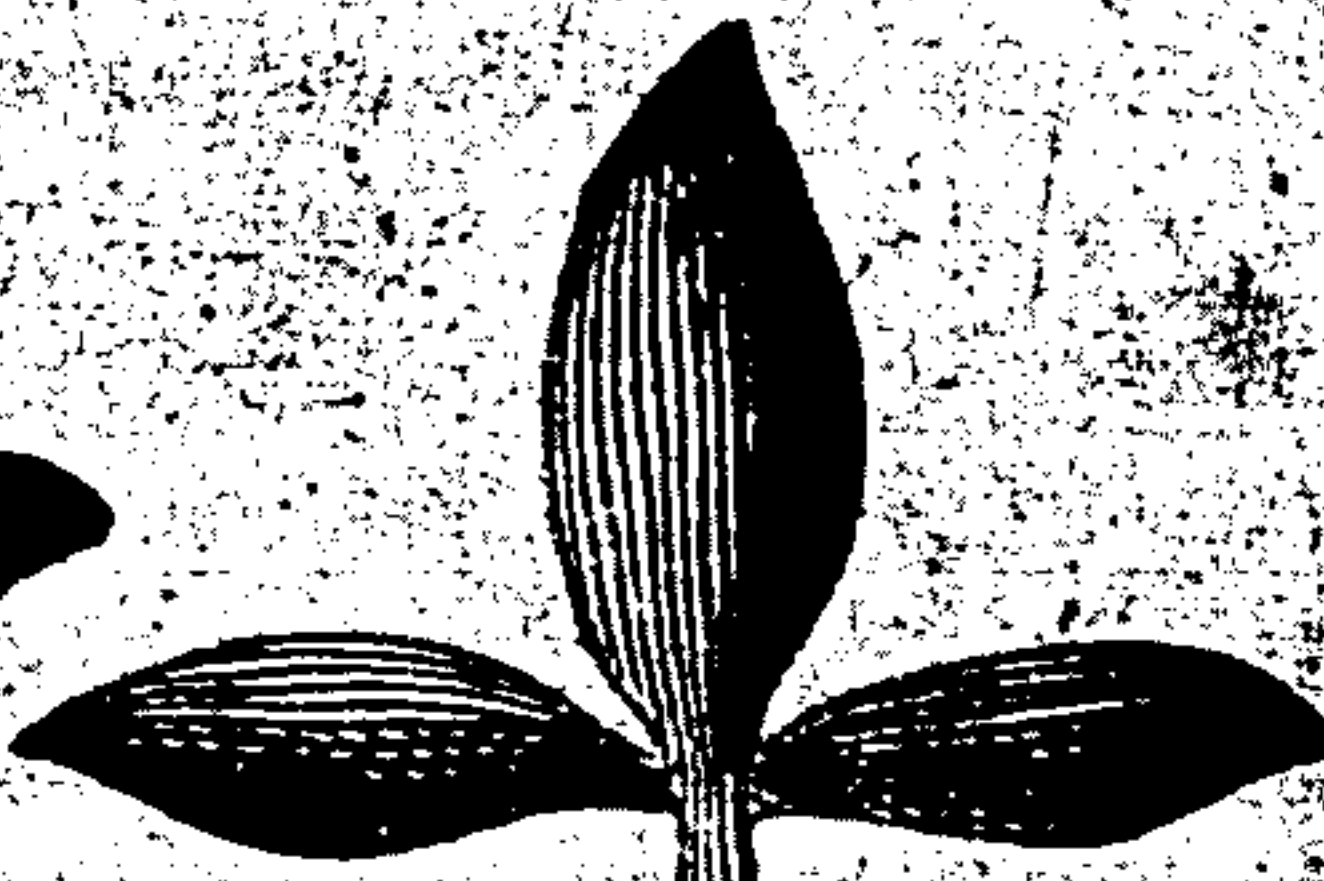
Sulcate



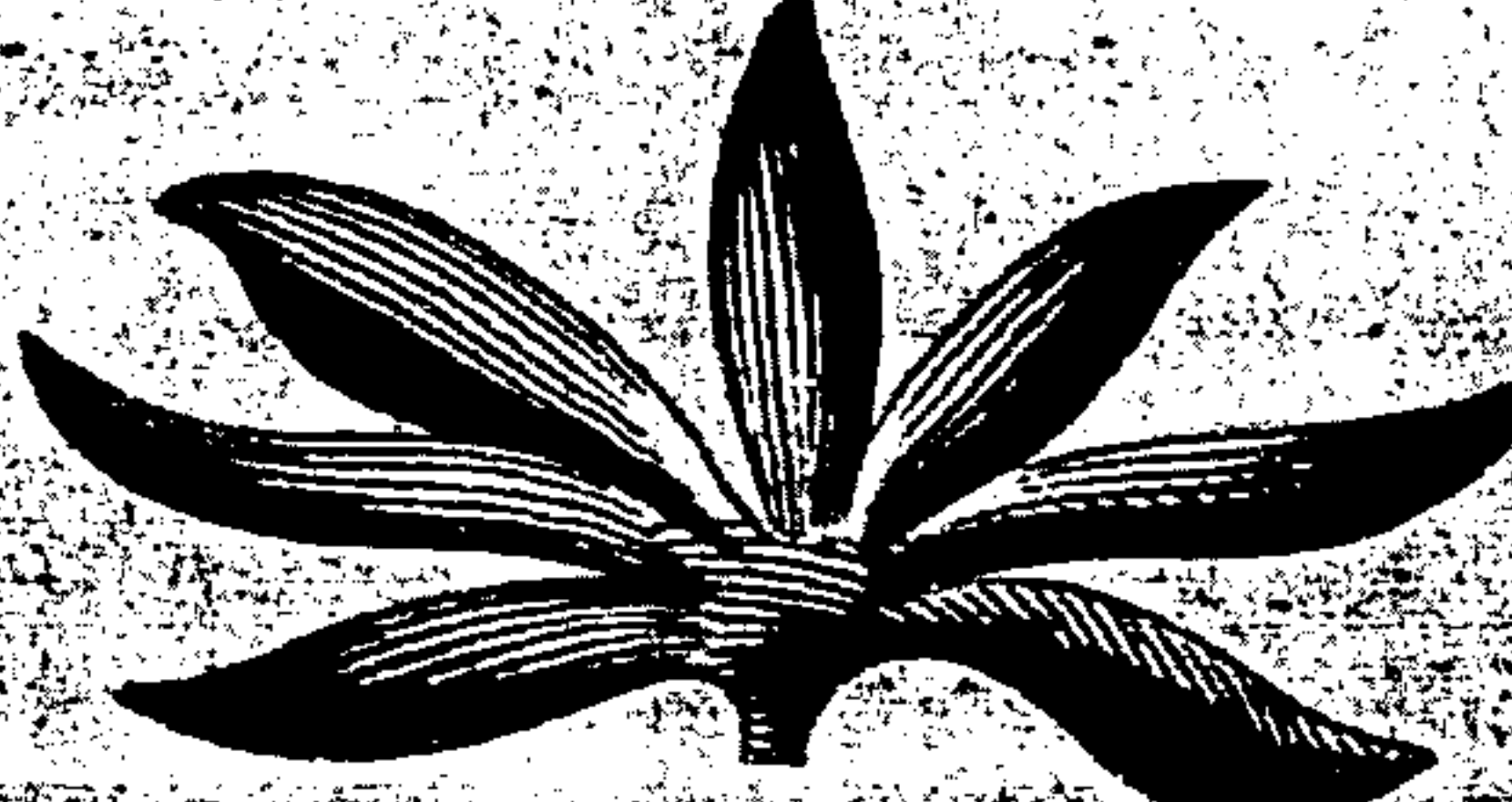
Binate



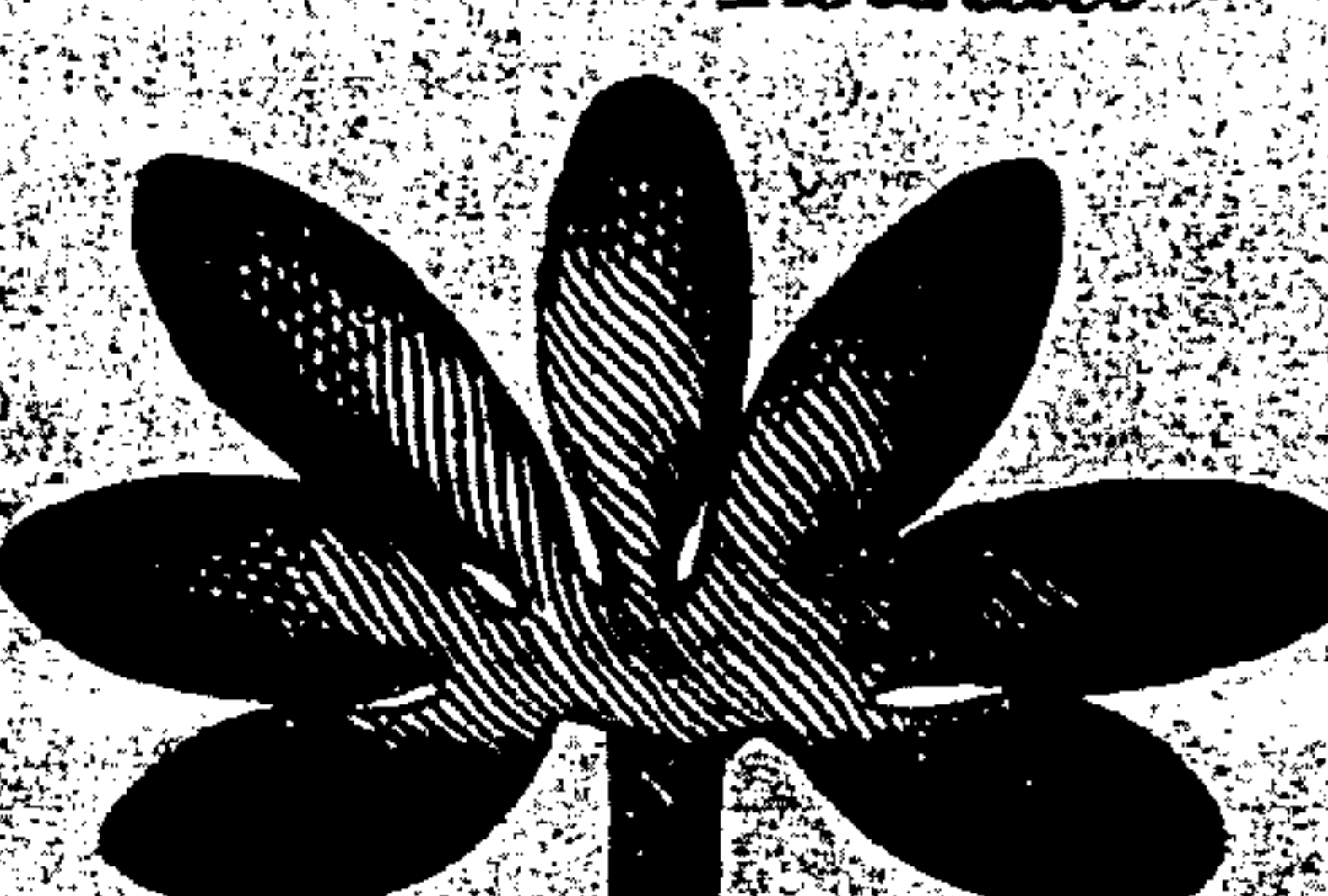
Ternate sessile



Ternate petiolated



Digitated



Pedated



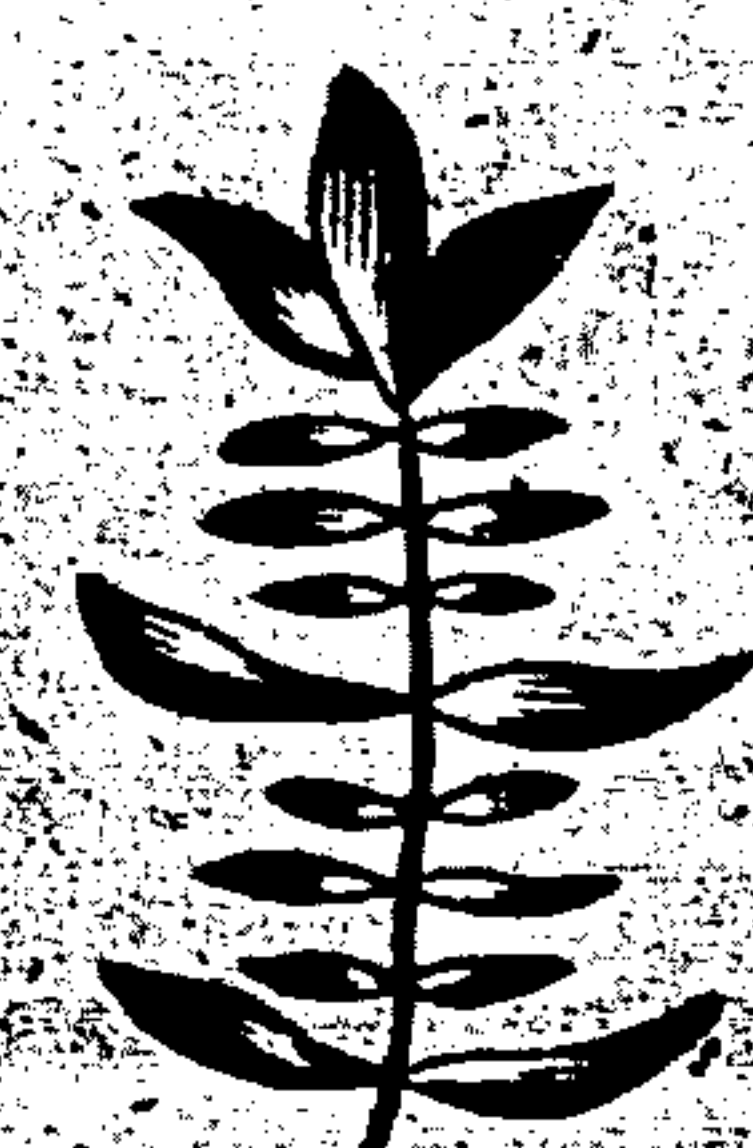
Pinnated with an Odd Leaf



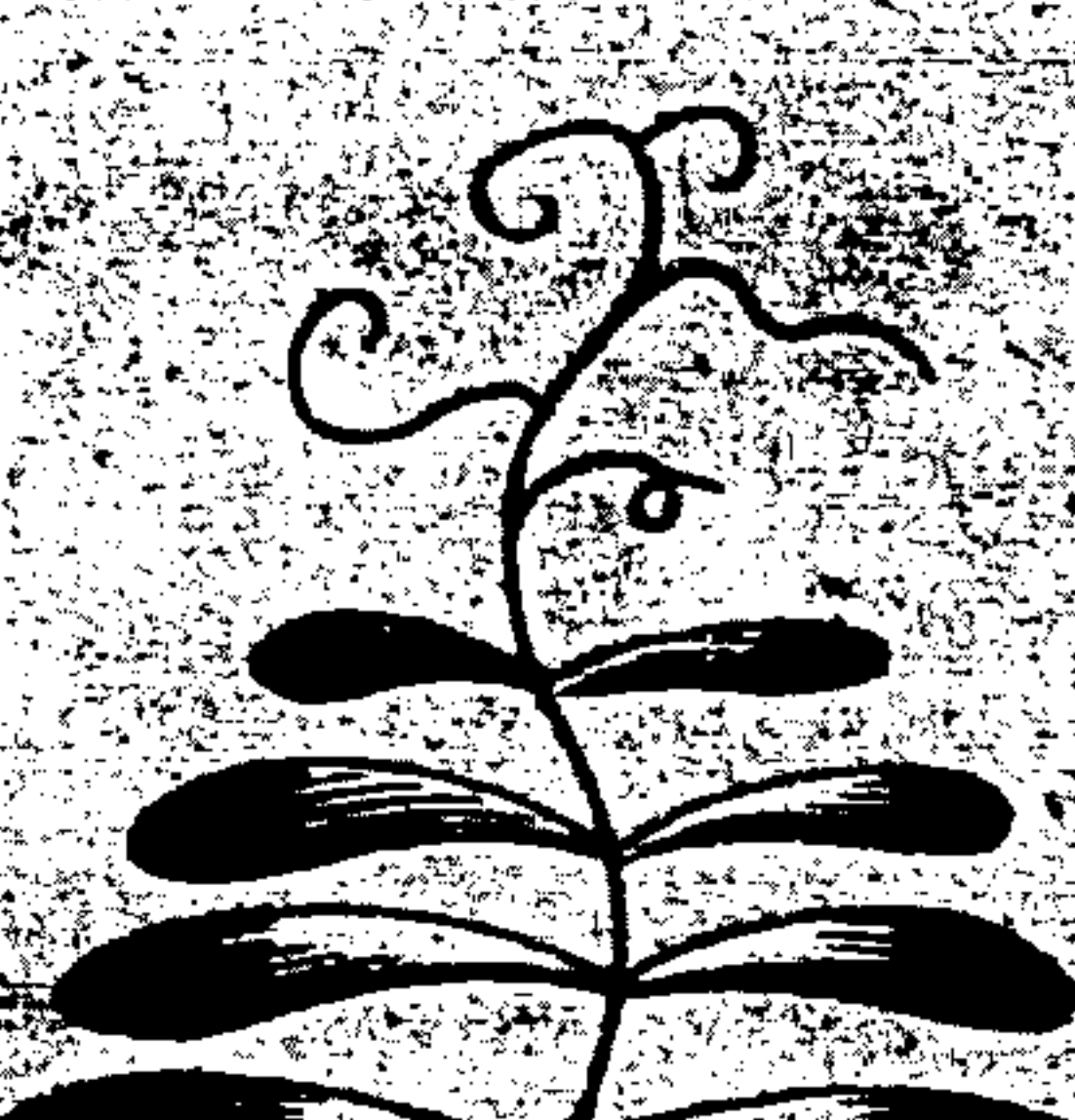
Pinnated without an Odd Leaf



Pinnated abrupt



Interruptedly pinnated



Pinnated & Cirrhose



Conjugately pinnated



Decursively pinnated



Articulately pinnated

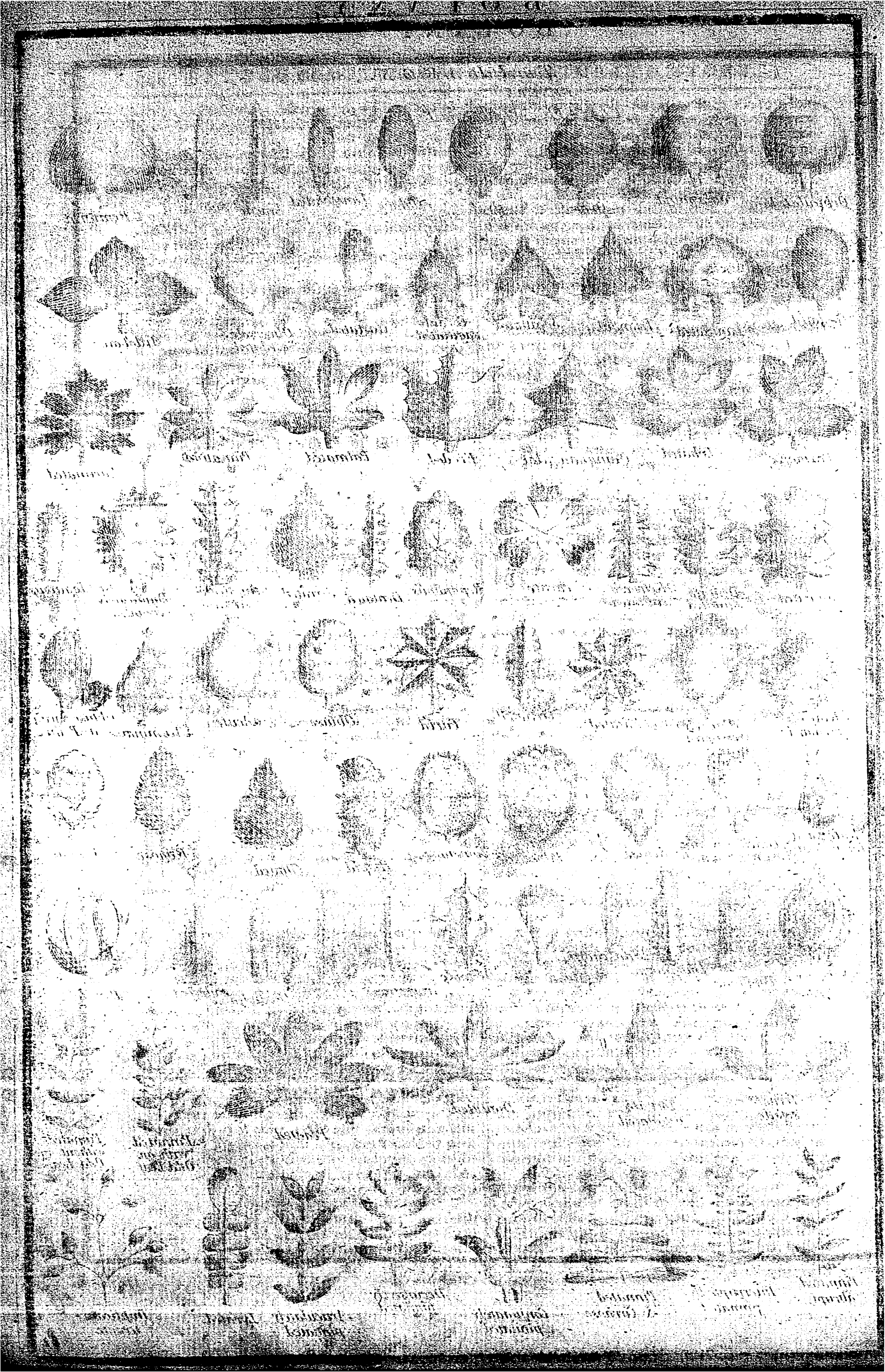


Lyrated



Duplicately ternate







# BOTANY

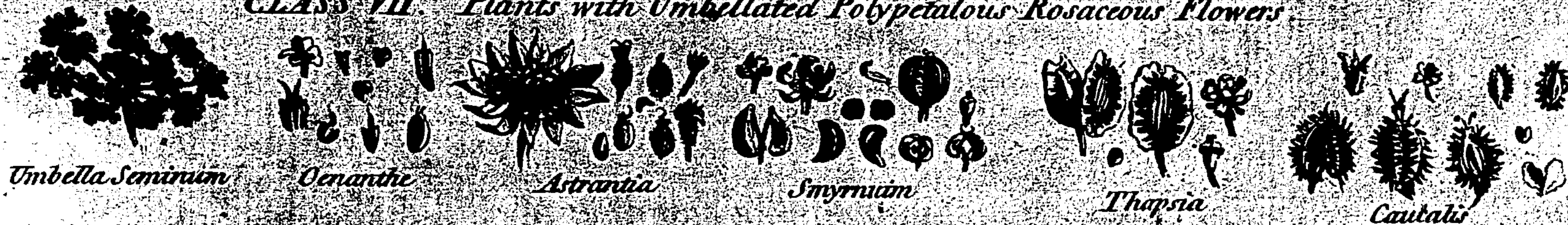
## Tournefort's System

### GENERA of PLANTS

#### CLASS VI. Plants with Rosaceous Flowers.



#### CLASS VII. Plants with Umbellated Polypetalous Rosaceous Flowers.



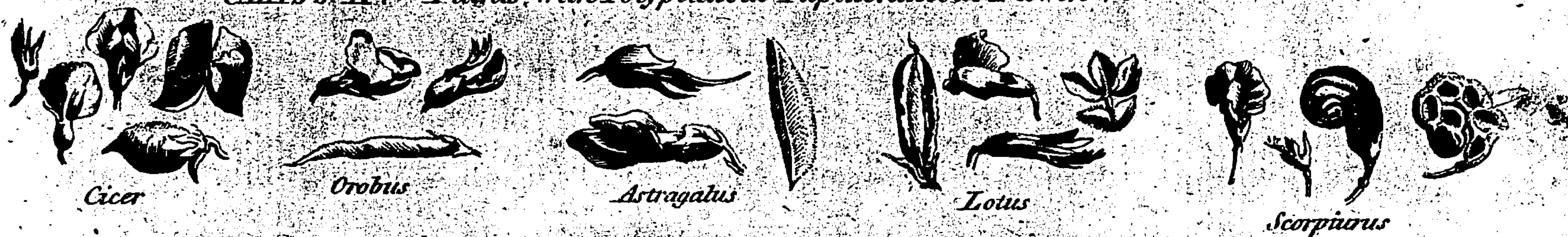
#### CLASS VIII. Plants with Polypetalous Caryophylleous Flowers.



#### CLASS IX. Plants with Liliaceous Flowers.



#### CLASS X. Plants with Polypetalous Papilionaceous Flowers.



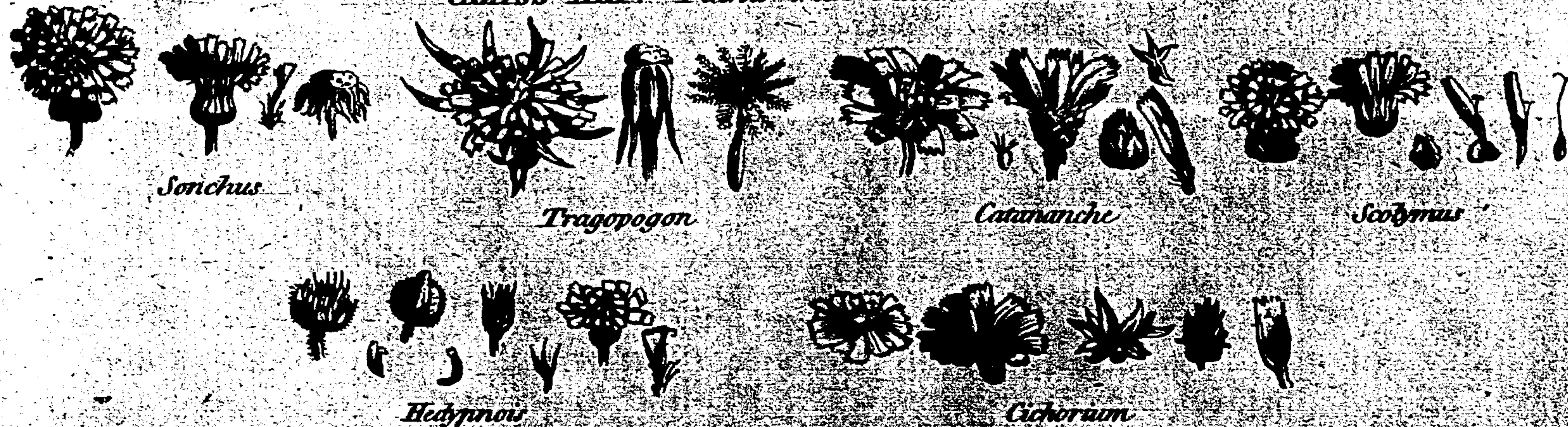
#### CLASS XI. Plants with Polypetalous Anomalous Flowers.



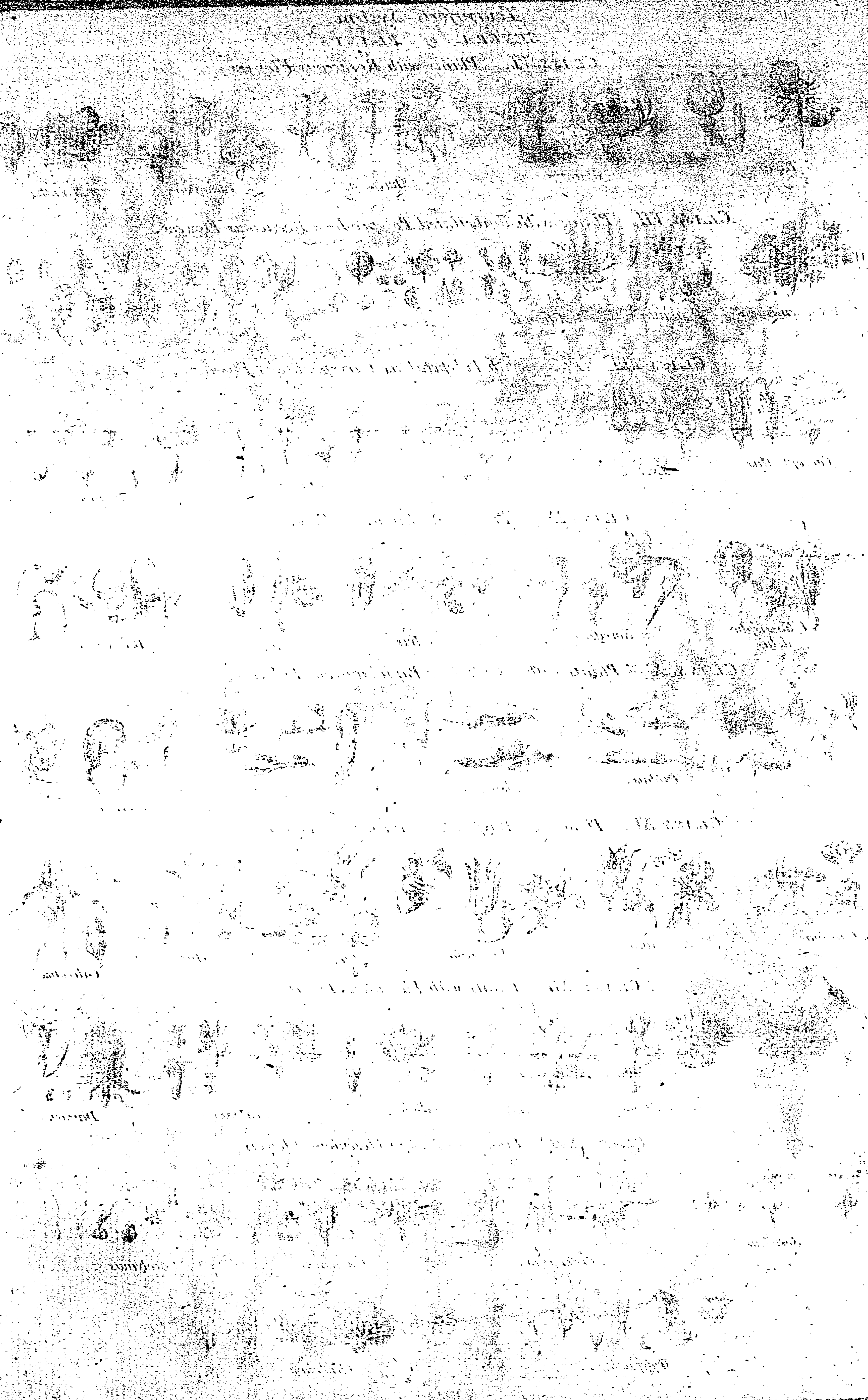
#### CLASS XII. Plants with Flosculous Flowers.



#### CLASS XIII. Plants with Semiflosculous Flowers.



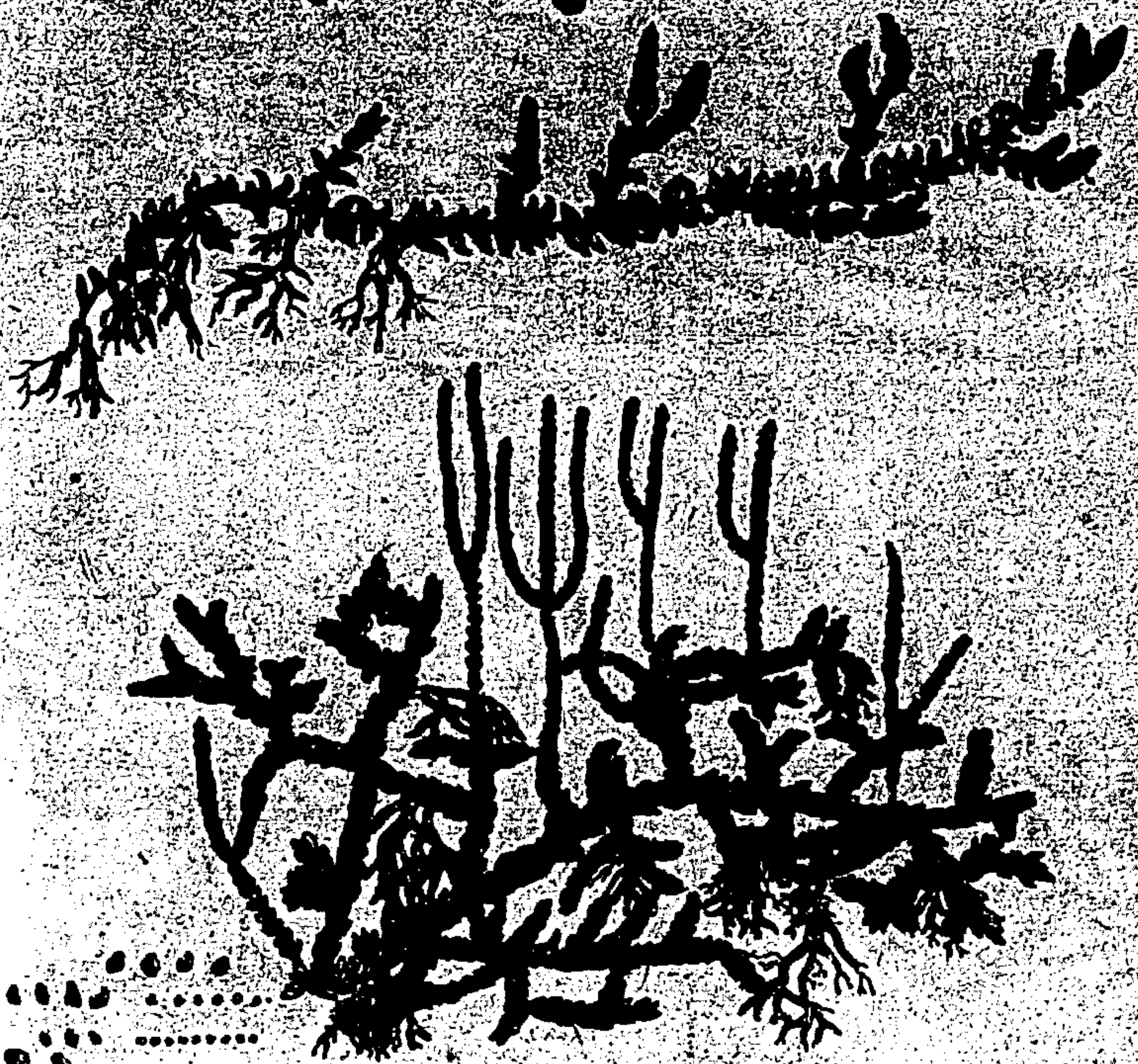




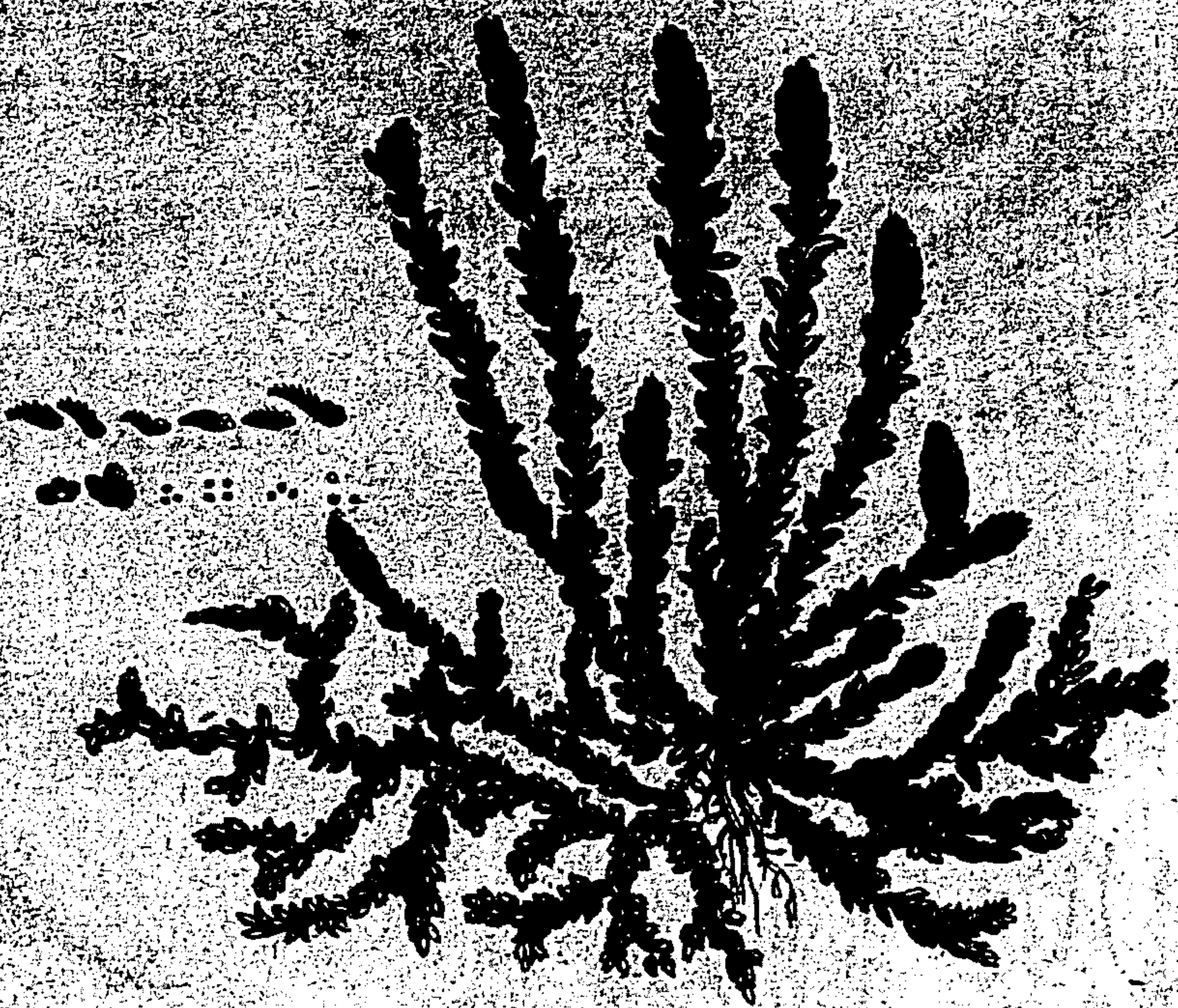


# BOTANY

## Genera of MOSSES.



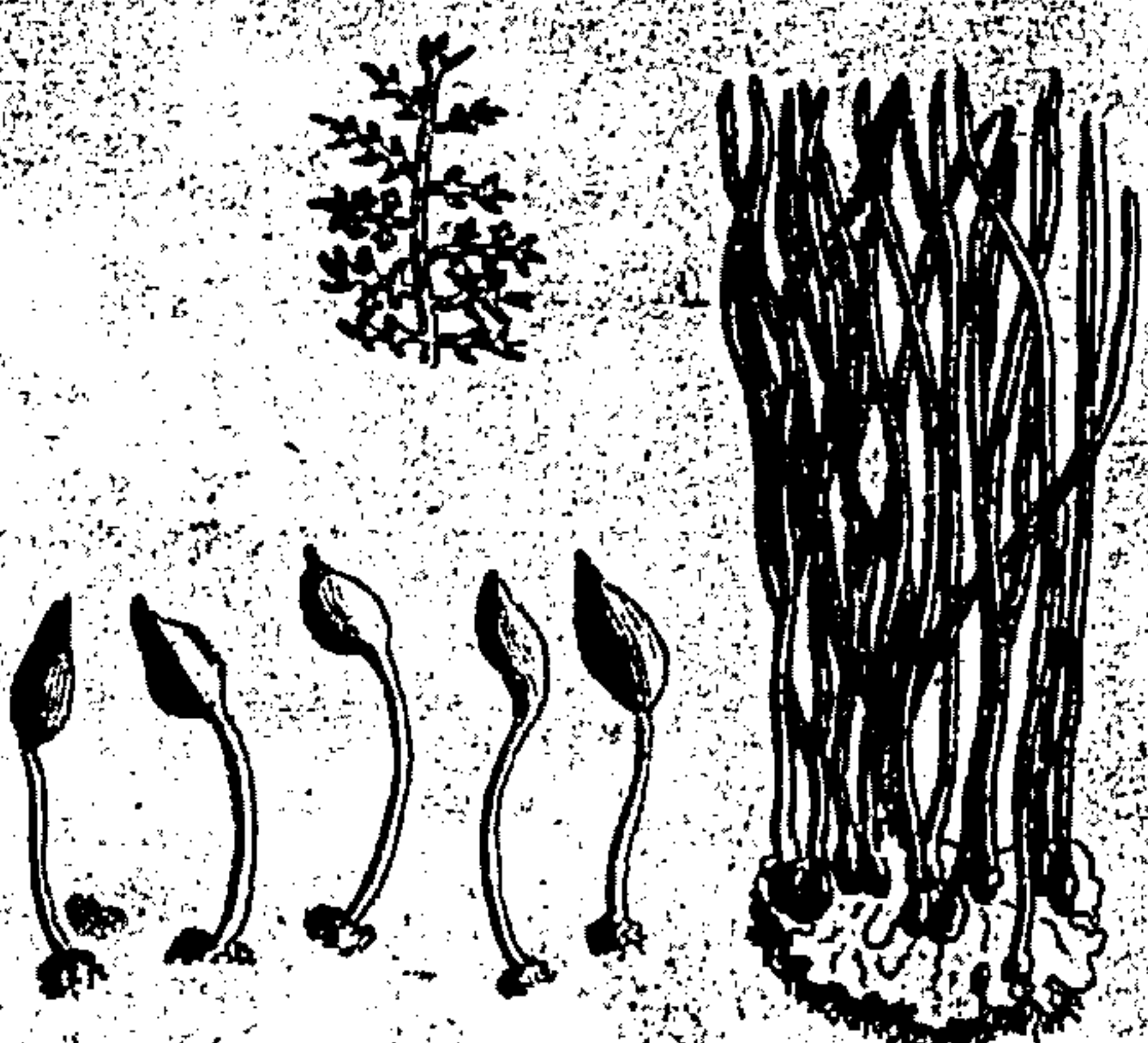
LYCOPODIODES



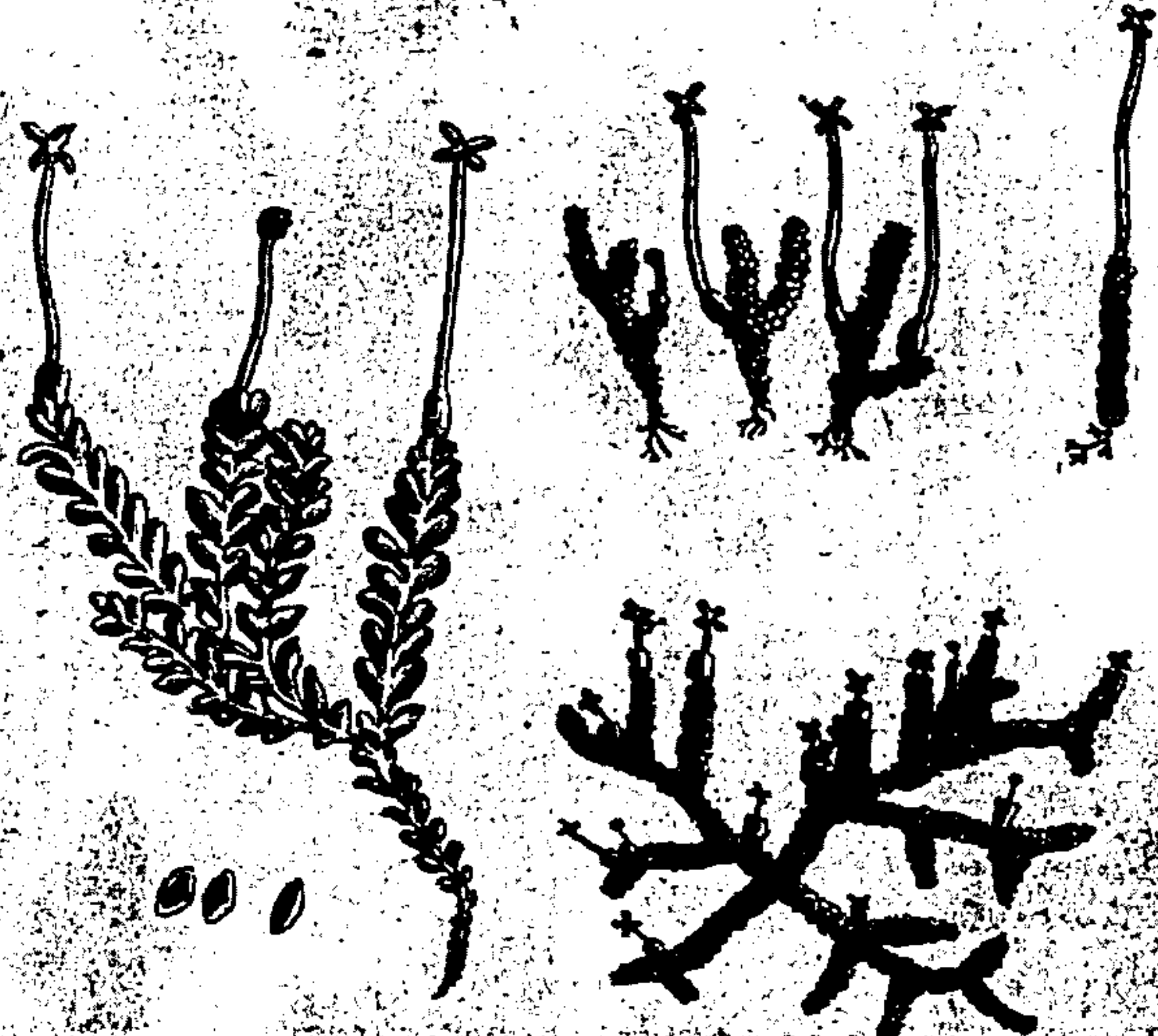
SELAGINOIDES



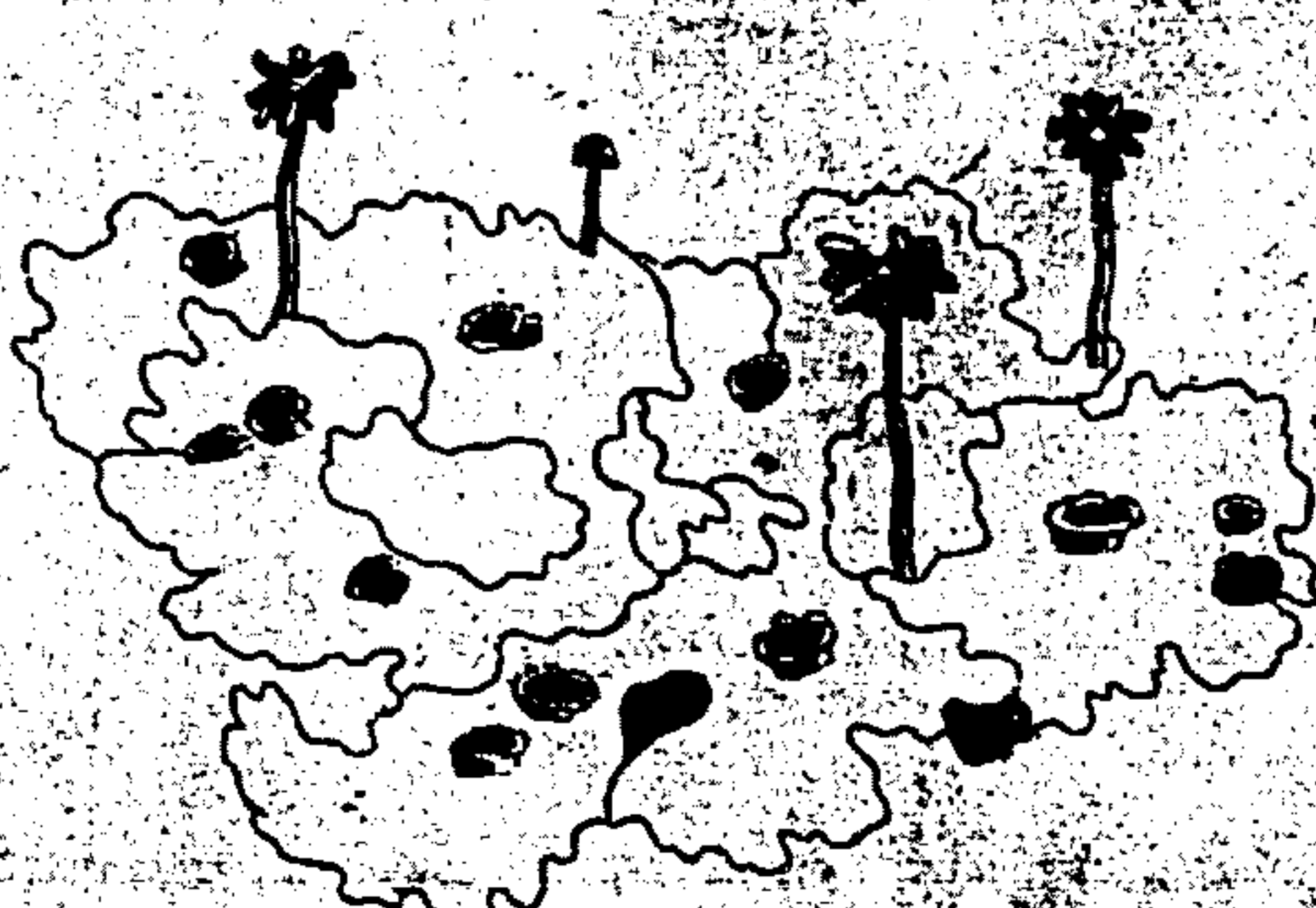
PORELLA



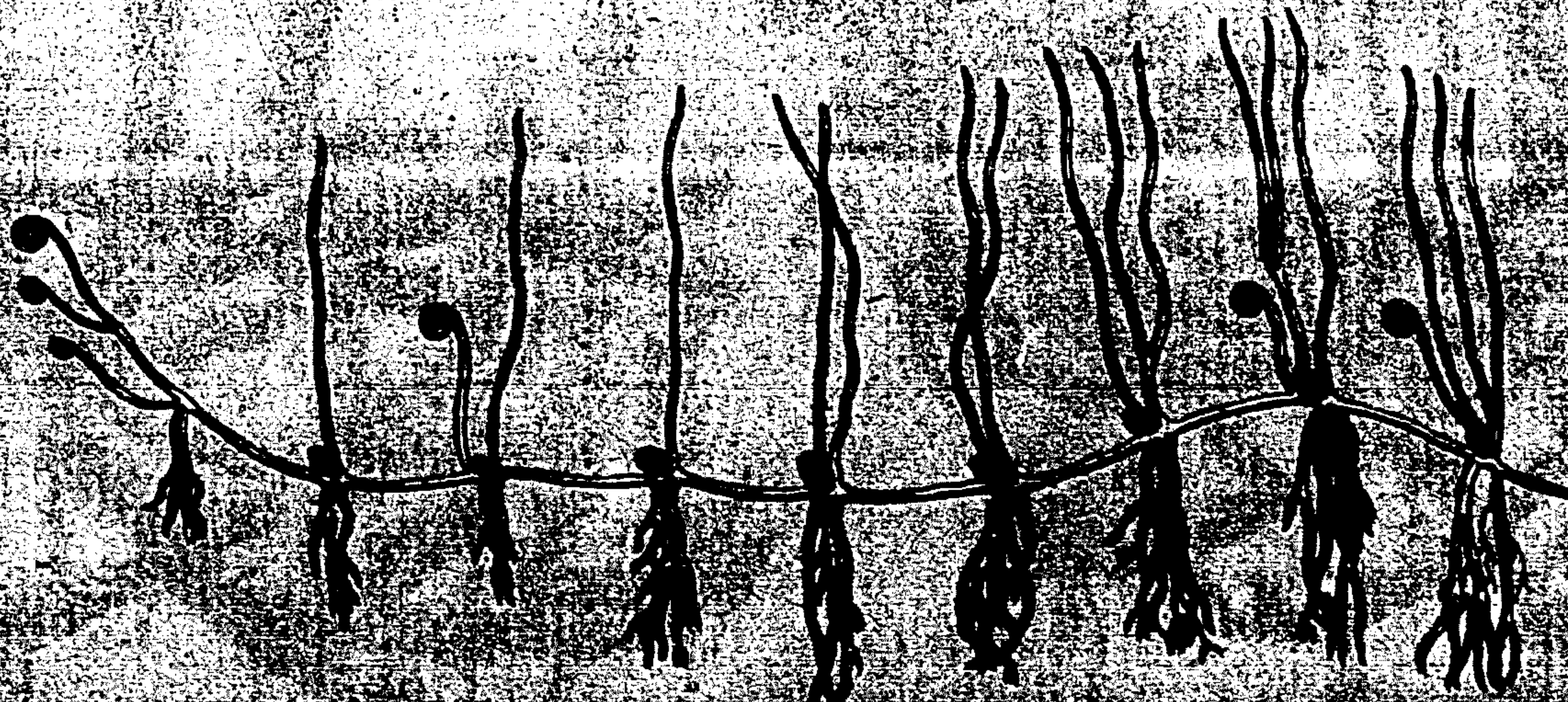
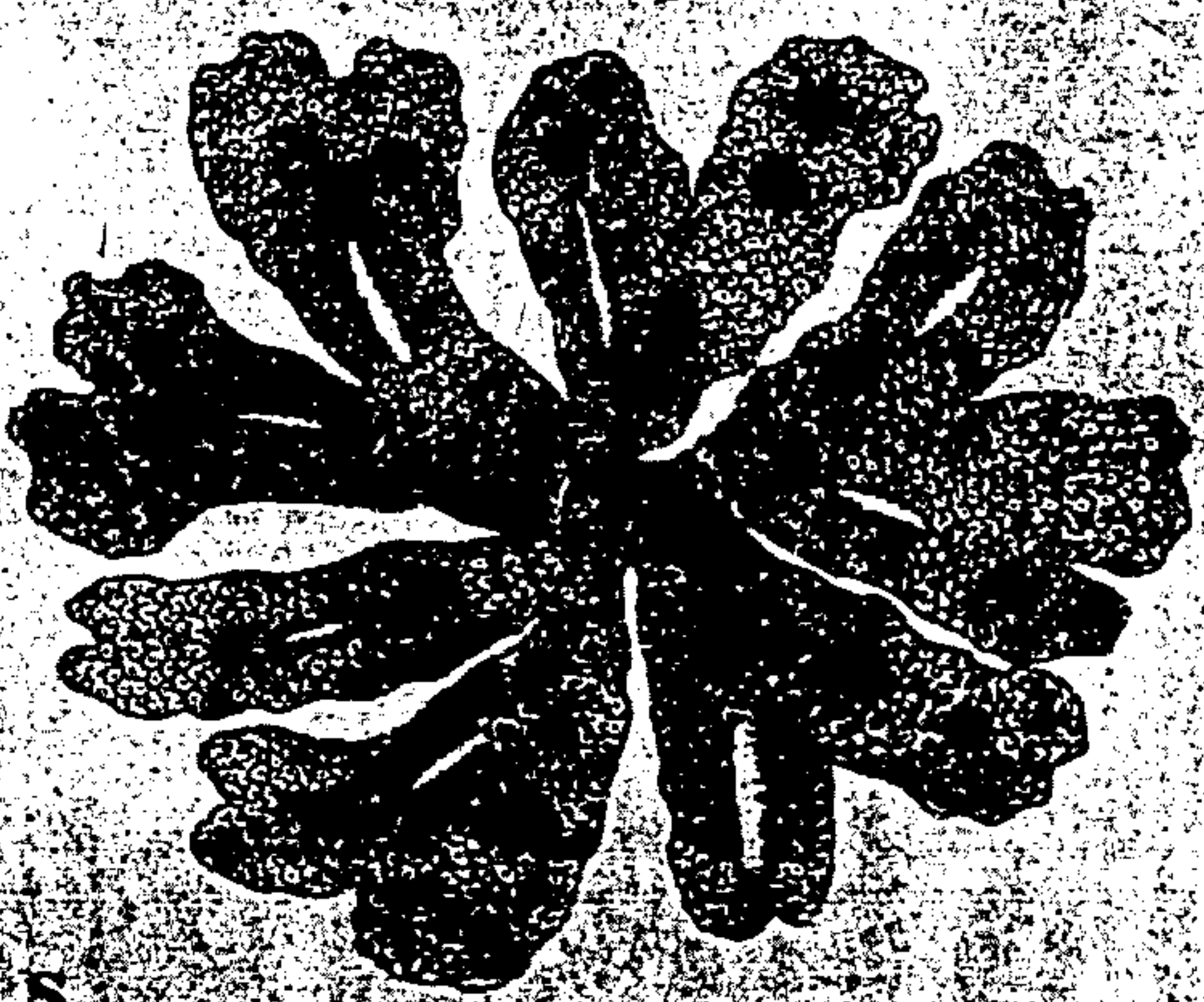
ANTHOCEROS



LICHENASTRA



LICHENE S



PERLUCIDARIA



BOULET 17

BOULET 17

BOULET 17

BOULET 17

BOULET 17



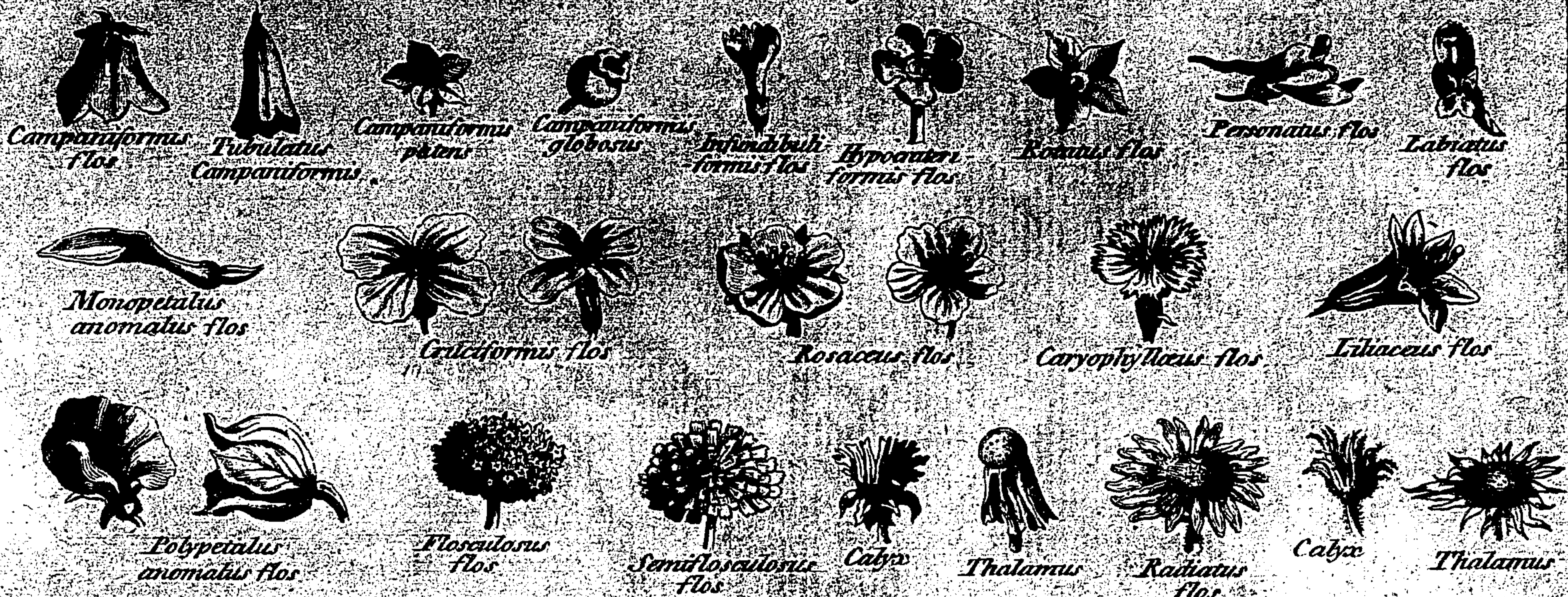
# BOTANY

## TOURNEFORT'S SYSTEM

### GENERAL CHARACTERS of FLOWERS

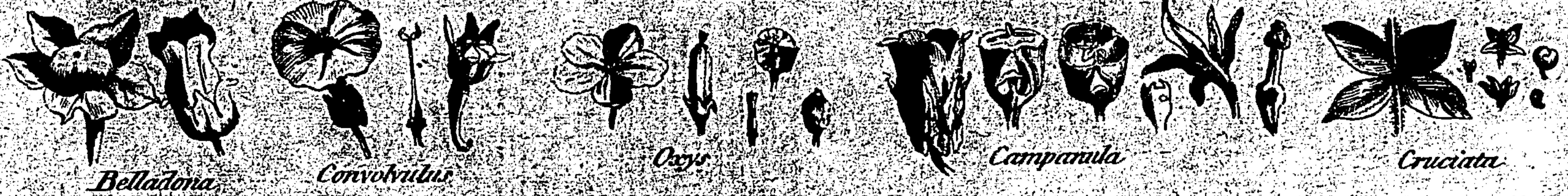


### CLASSICAL CHARACTERS of FLOWERS

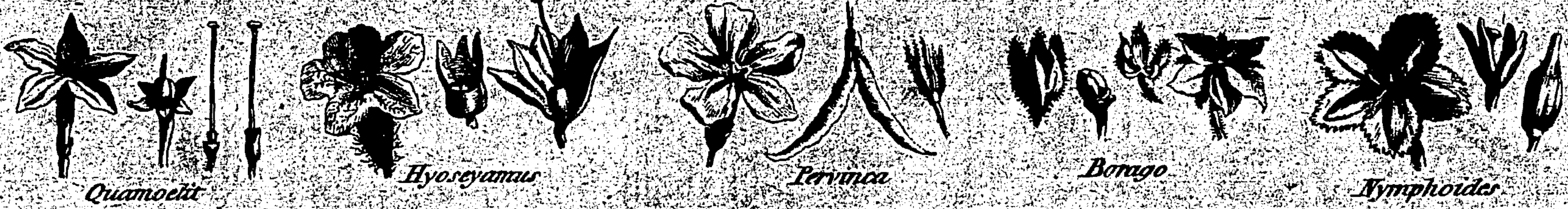


## GENERA of PLANTS

### CLASS I. Plants with Monopetalous Campaniform Flowers



### CLASS II. Plants with Monopetalous Infundibuliform & Rotated Flowers



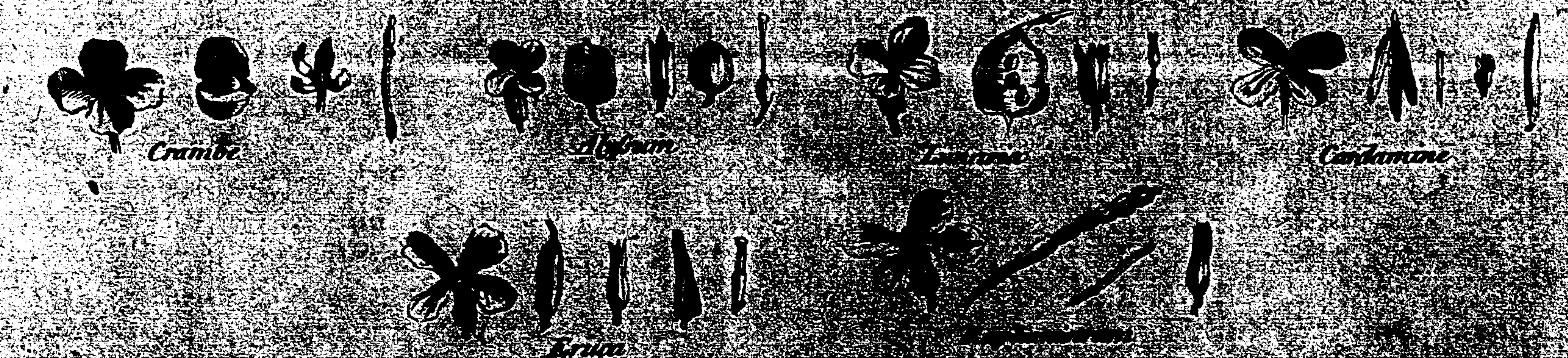
### CLASS III. Plants with Monopetalous Anomalous Flowers



### CLASS IV. Plants with Monopetalous Labiated Flowers

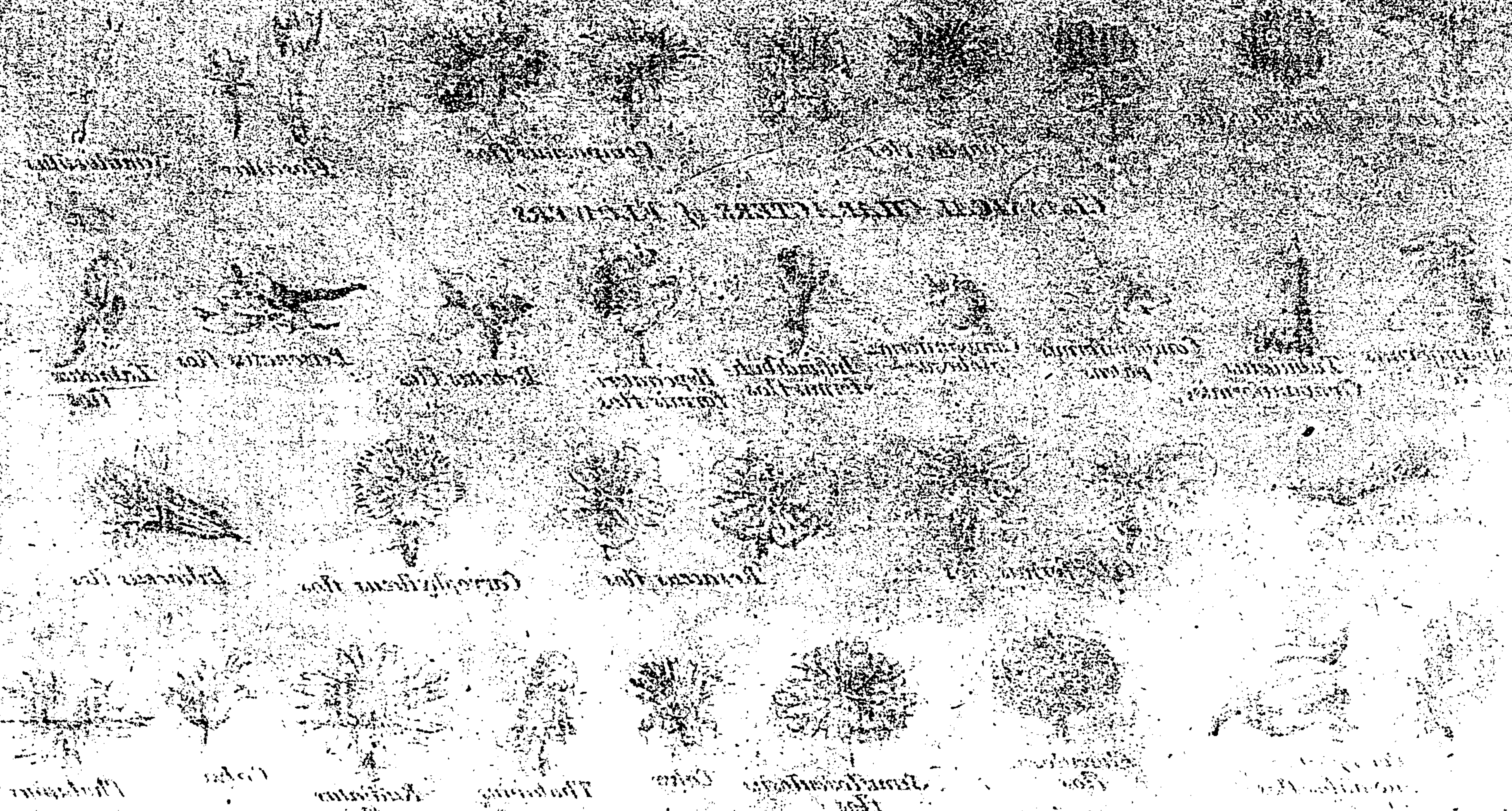


### CLASS V. Plants with Cruciform Polypetalous Flowers

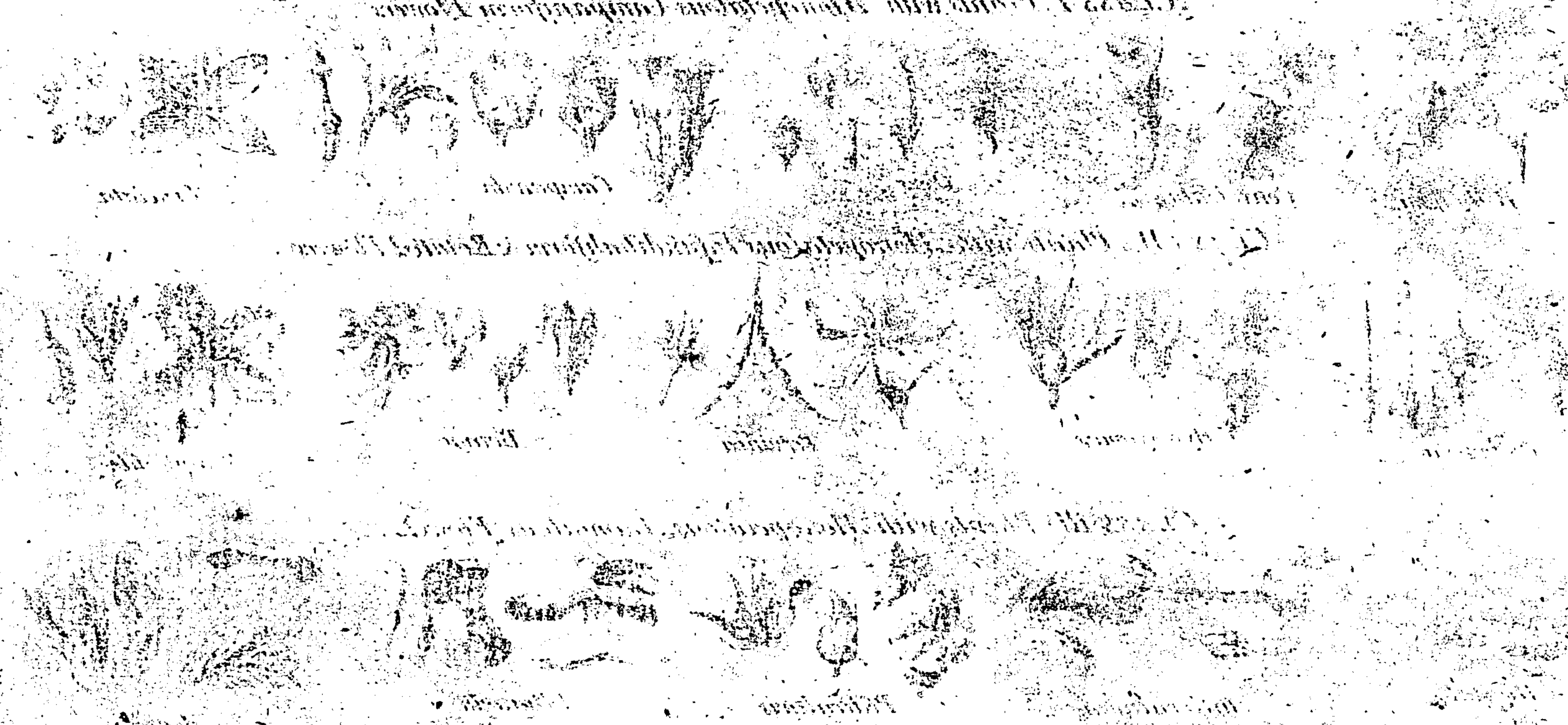




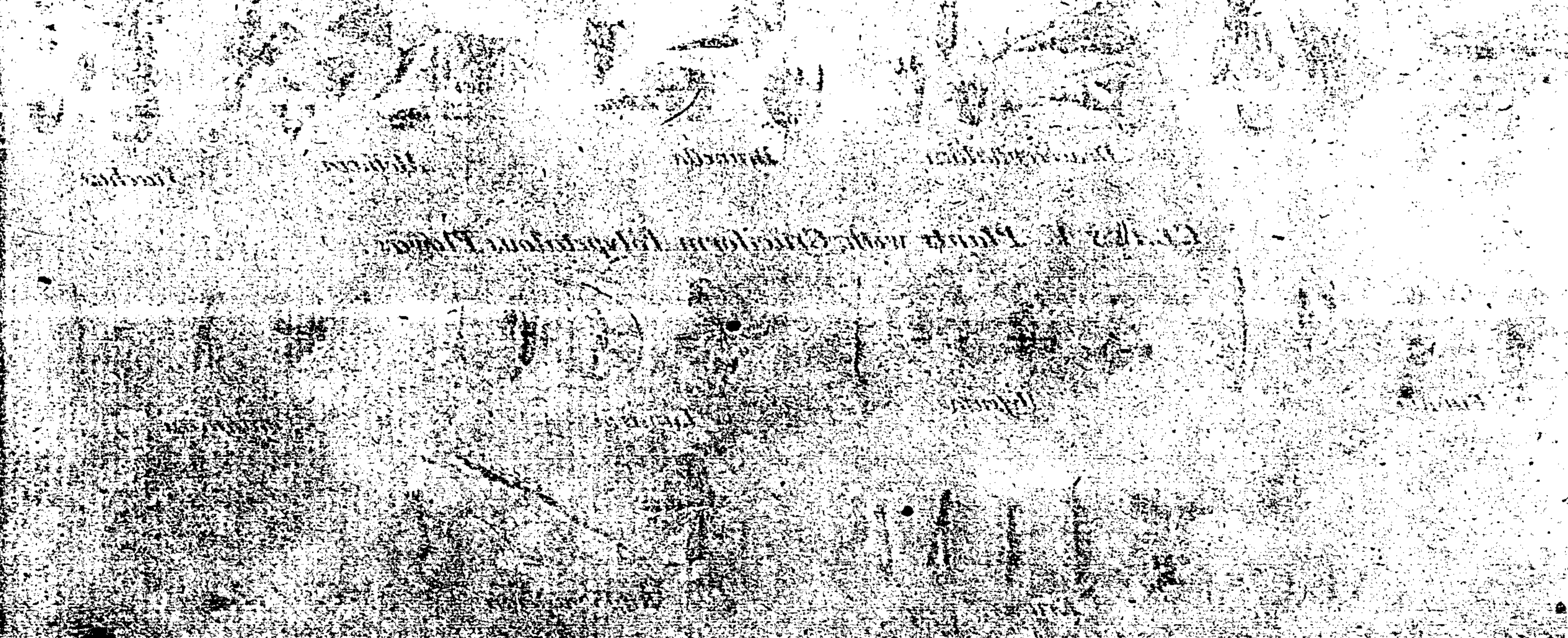
CLASS I. PLANTS WITH THROATED FLOWERS



CLASS II. PLANTS WITH THROATED FLOWERS



CLASS III. PLANTS WITH THROATED FLOWERS







**ABUTILON:**

*with leaves resembling those of a red gooseberry-tree, a flesh coloured flower, & fruit of a pentagonal or five cornered shape, & rough tasted.*

*The Hairy ABUTILON of the Shrub kind, with a roundish leaf, a large and spreading flower of a pale yellow colour, and a single Cup or Calyx.*

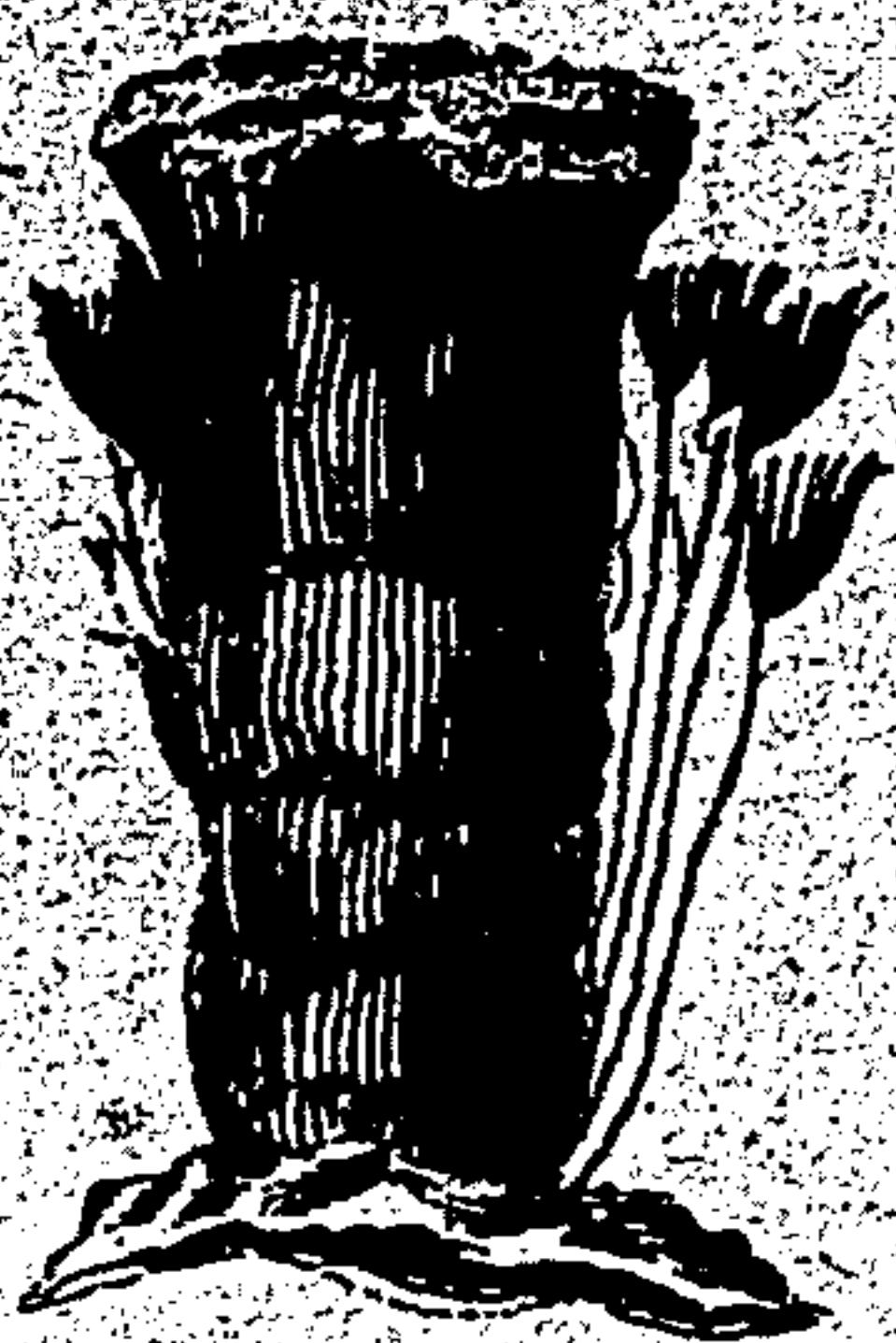






# BOTANY

## Genera of MOSSES.



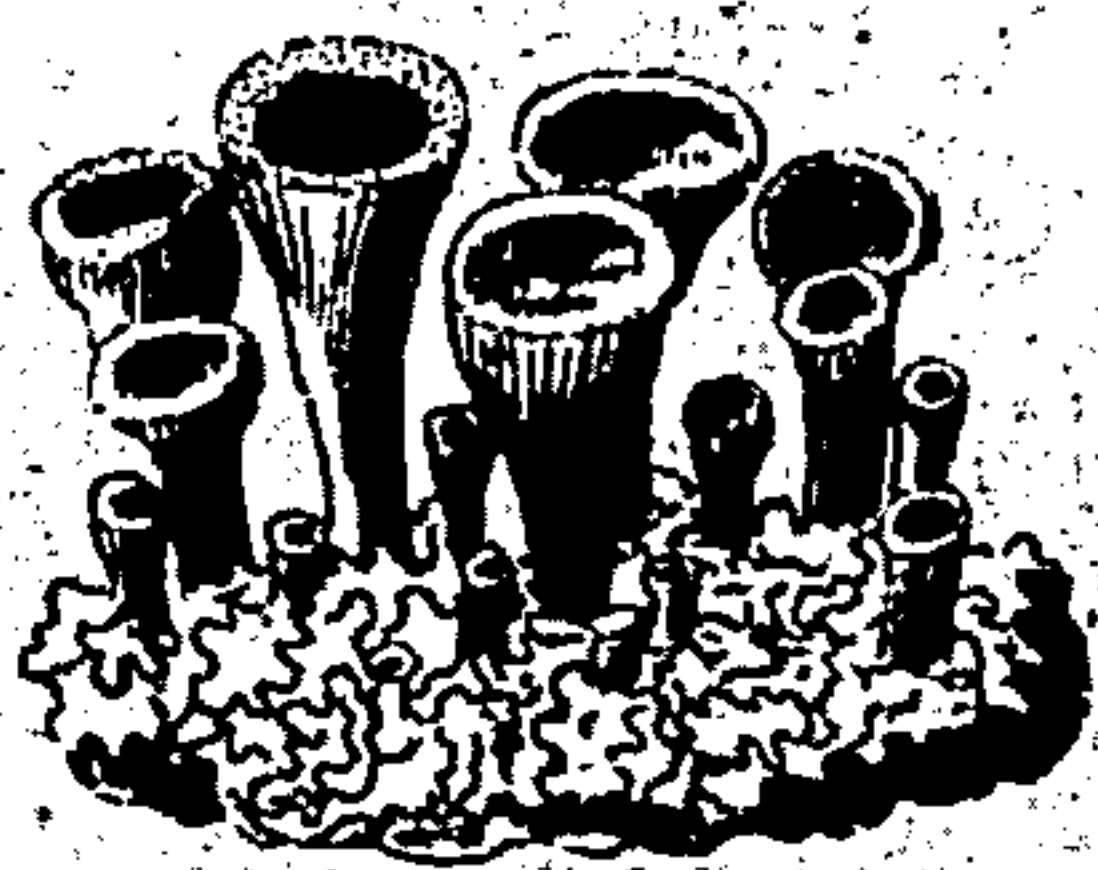
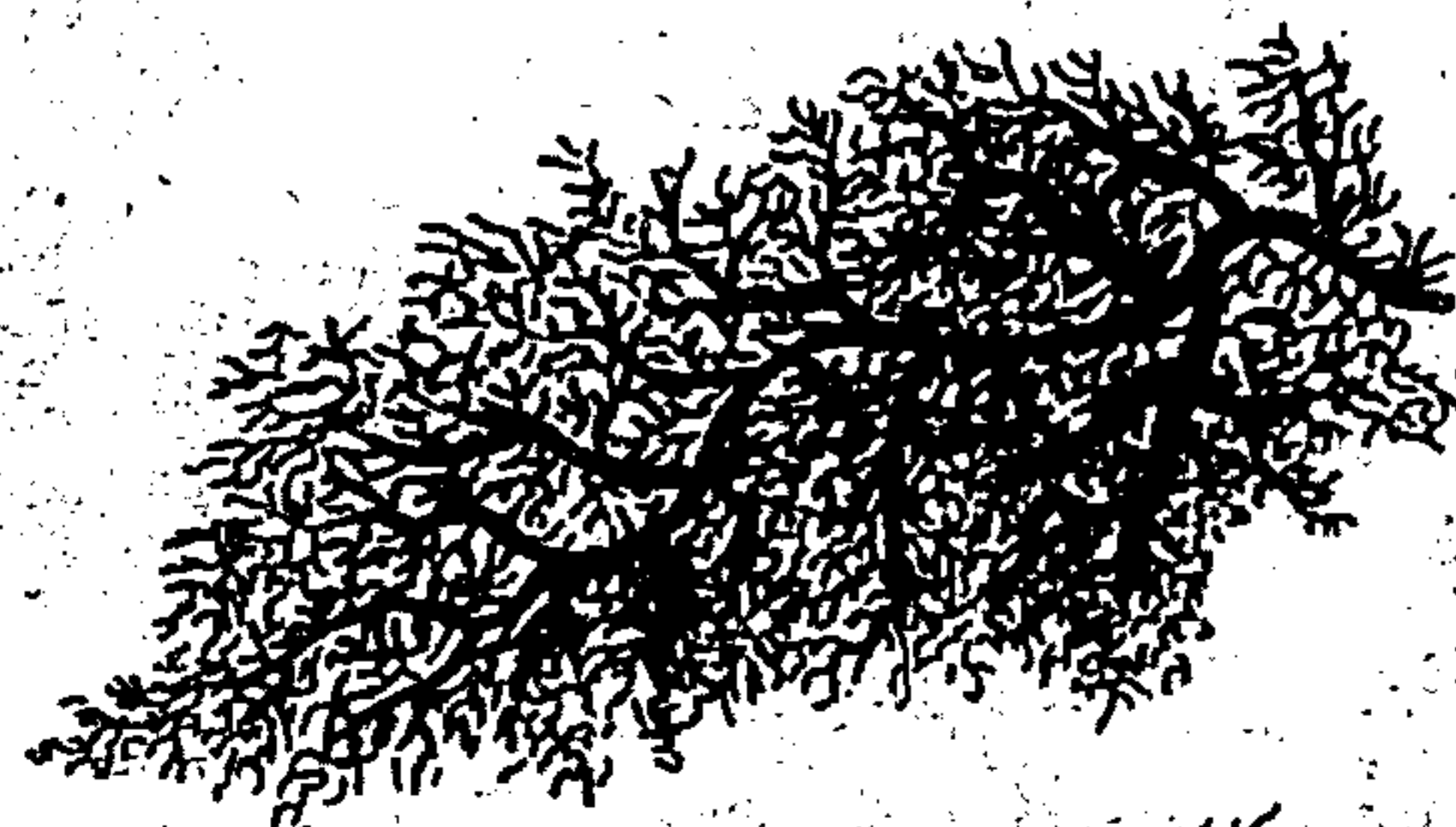
BYSSI



CONFERVÆ



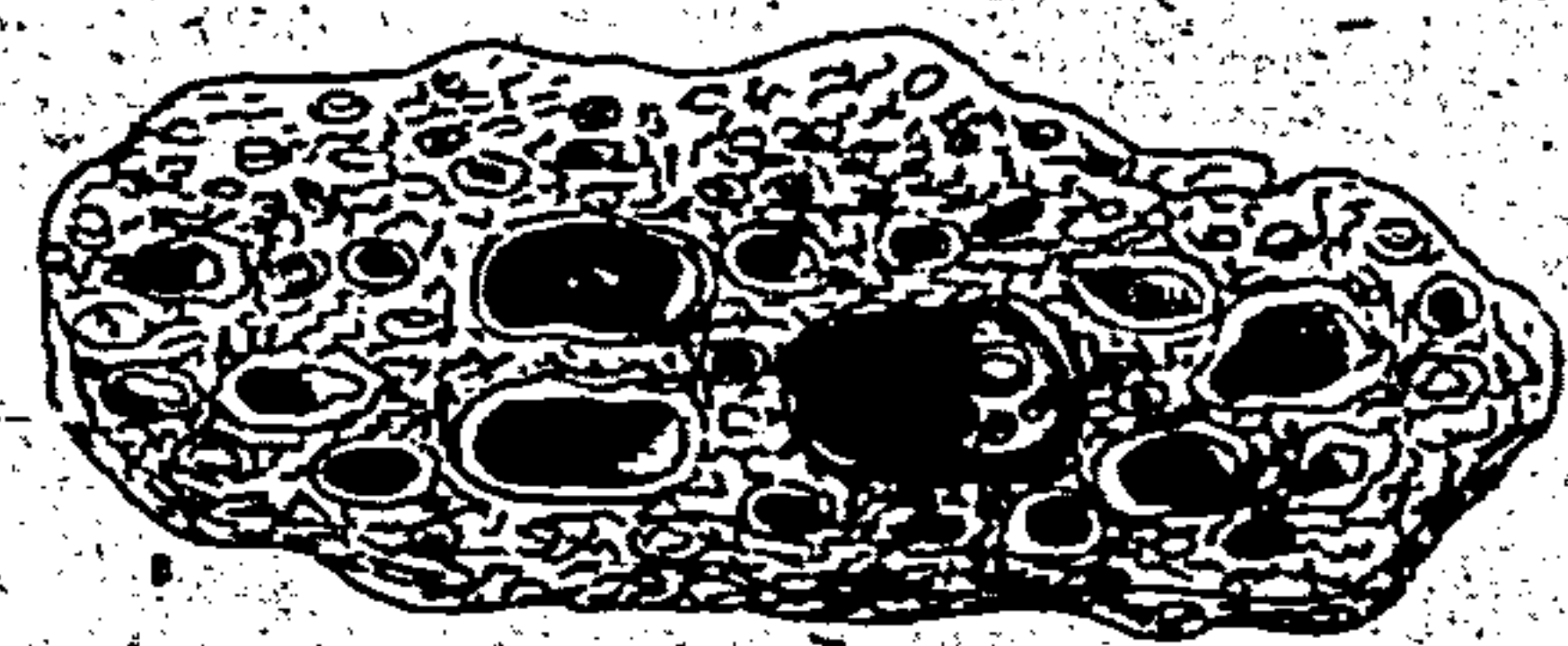
TREMELLÆ



USNEÆ

CORALLOIDES

MNIUM



LICHENOIDES

SPHAGNUM



77777777

77777777

77777777

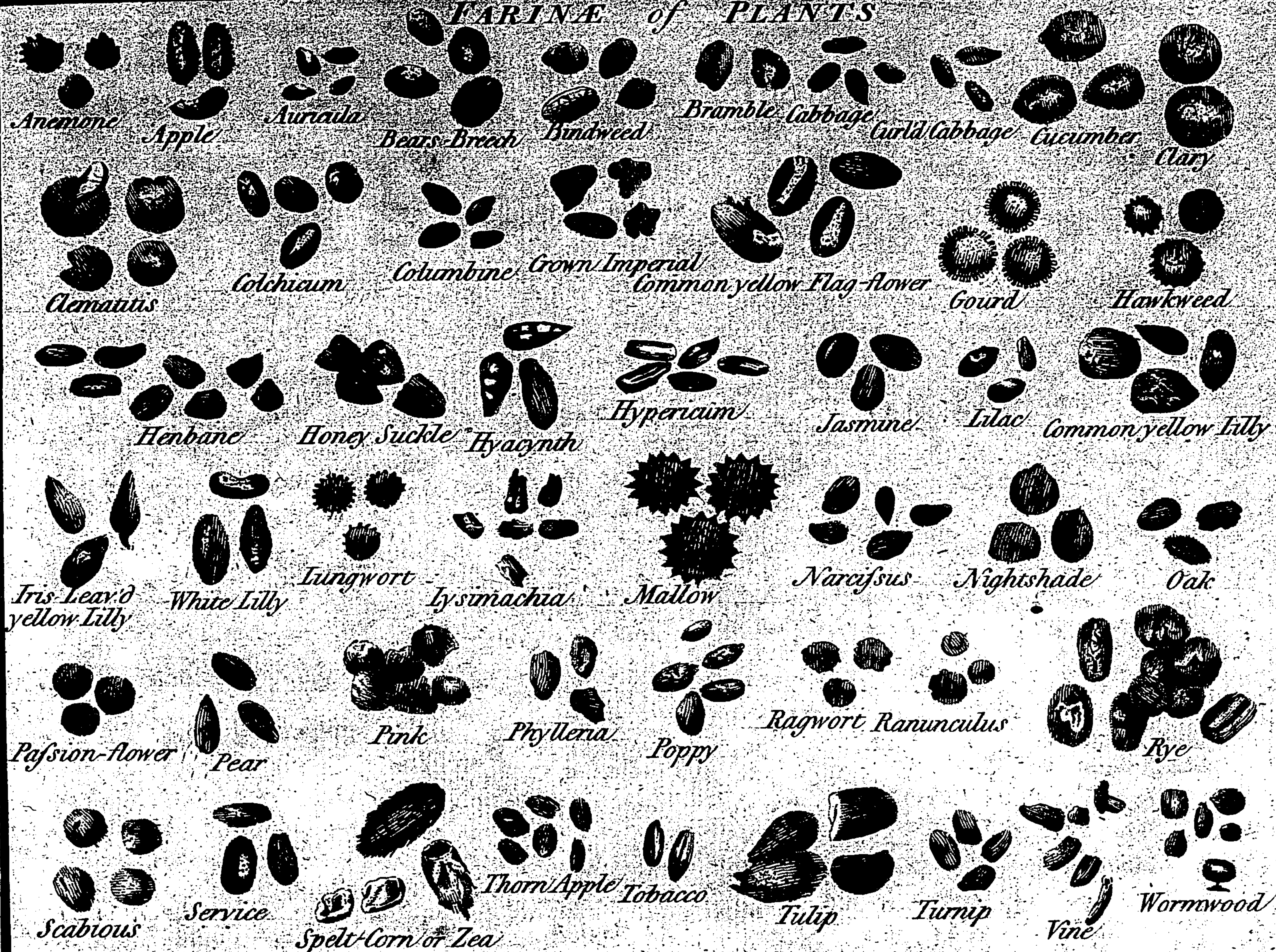
77777777



# MICROSCOPICAL OBJECTS

## Class II. Vegetable Subjects

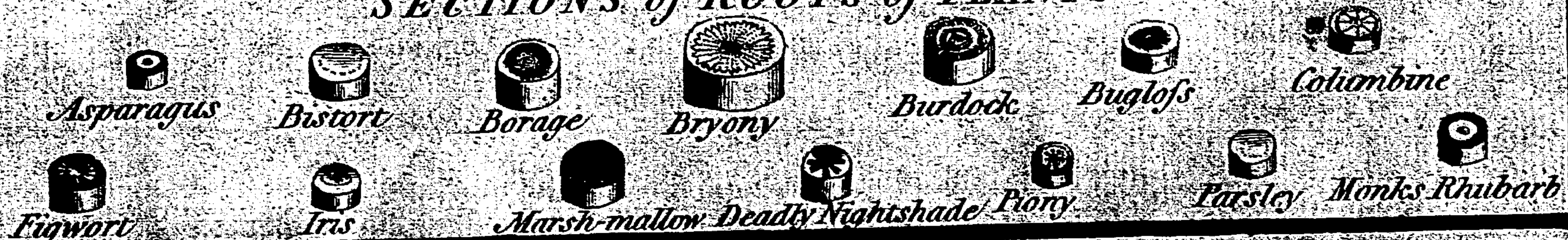
### FARINÆ of PLANTS



### SEEDS of PLANTS



### SECTIONS of ROOTS of PLANTS

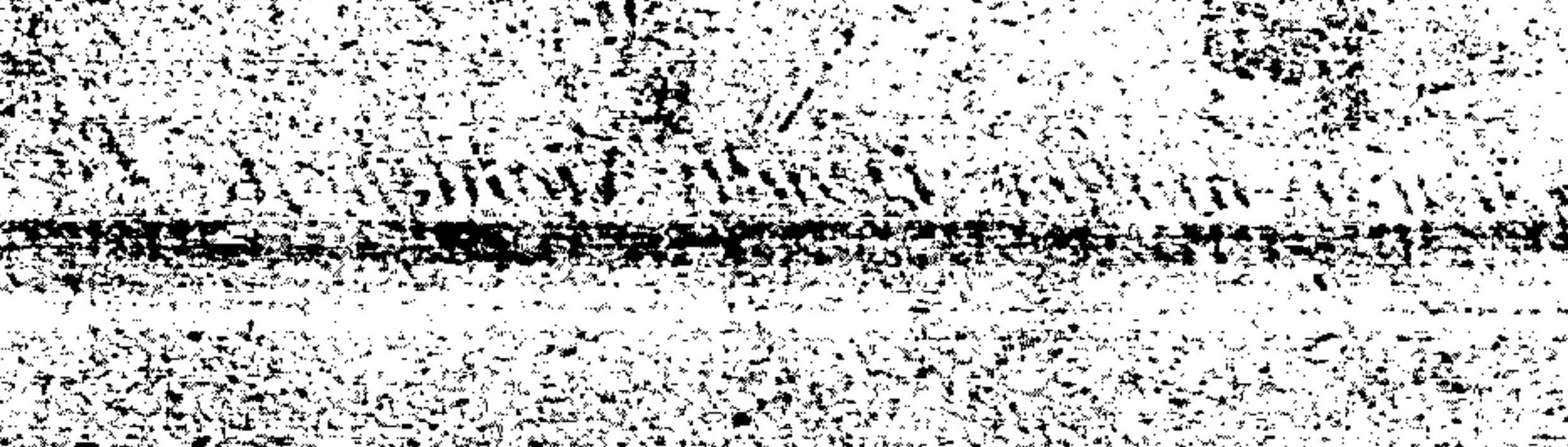
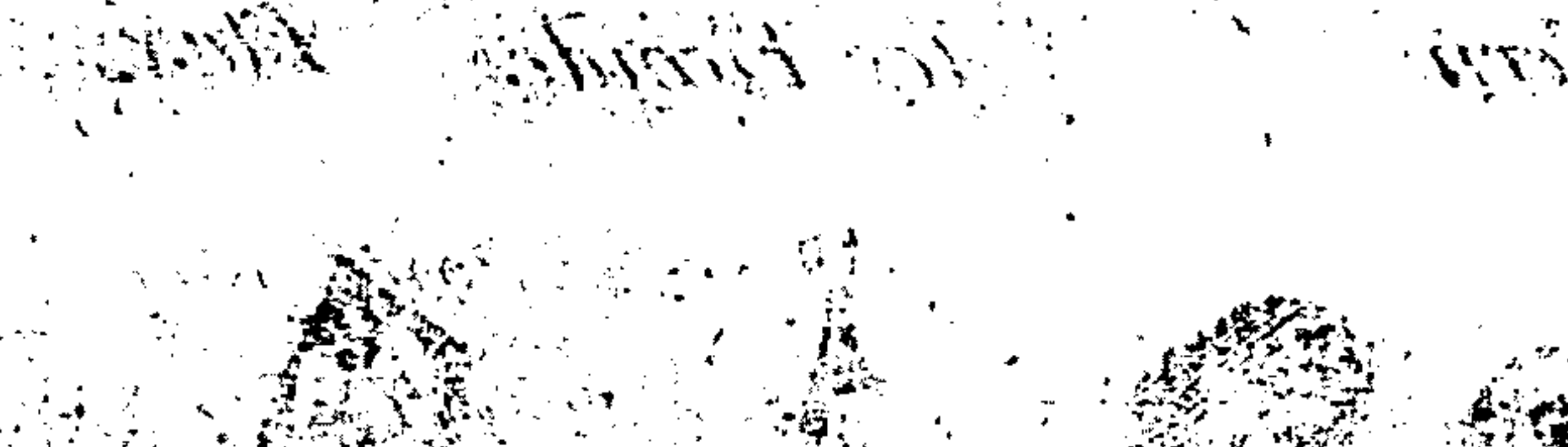
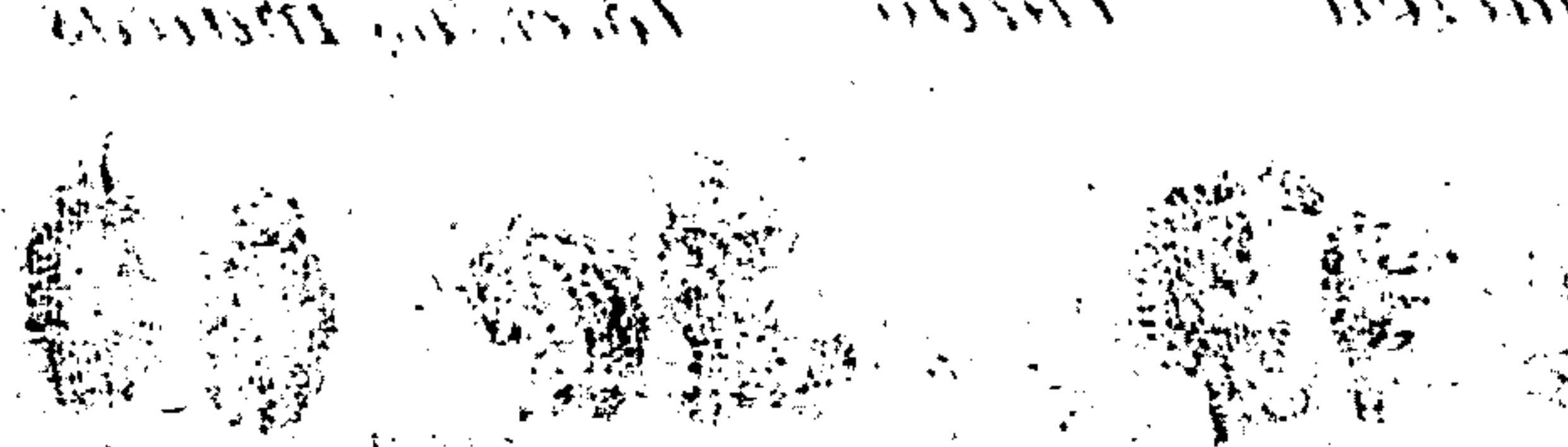
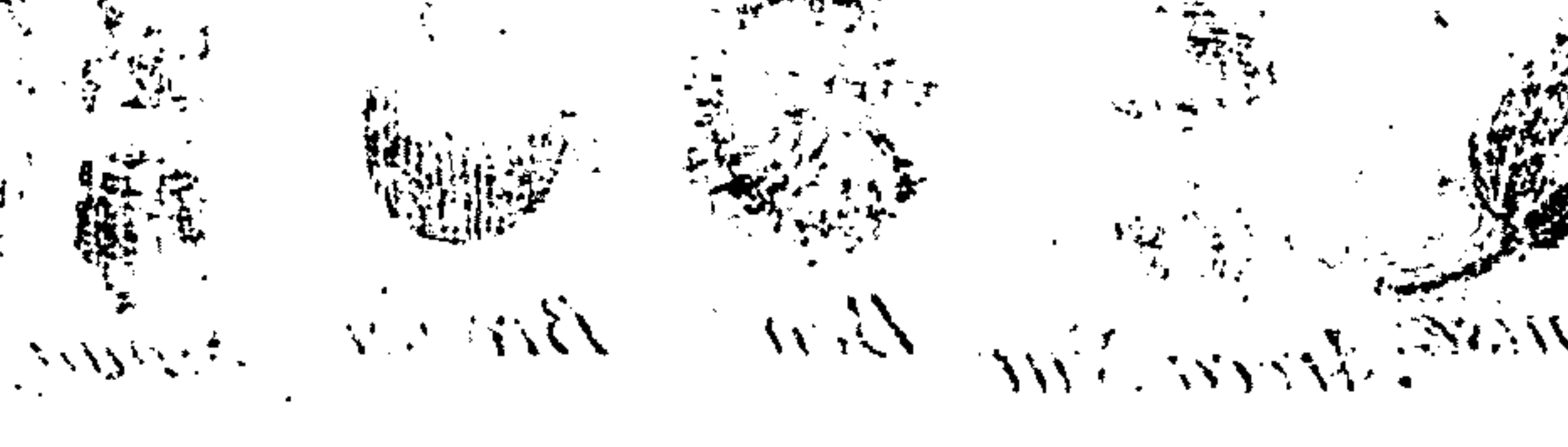
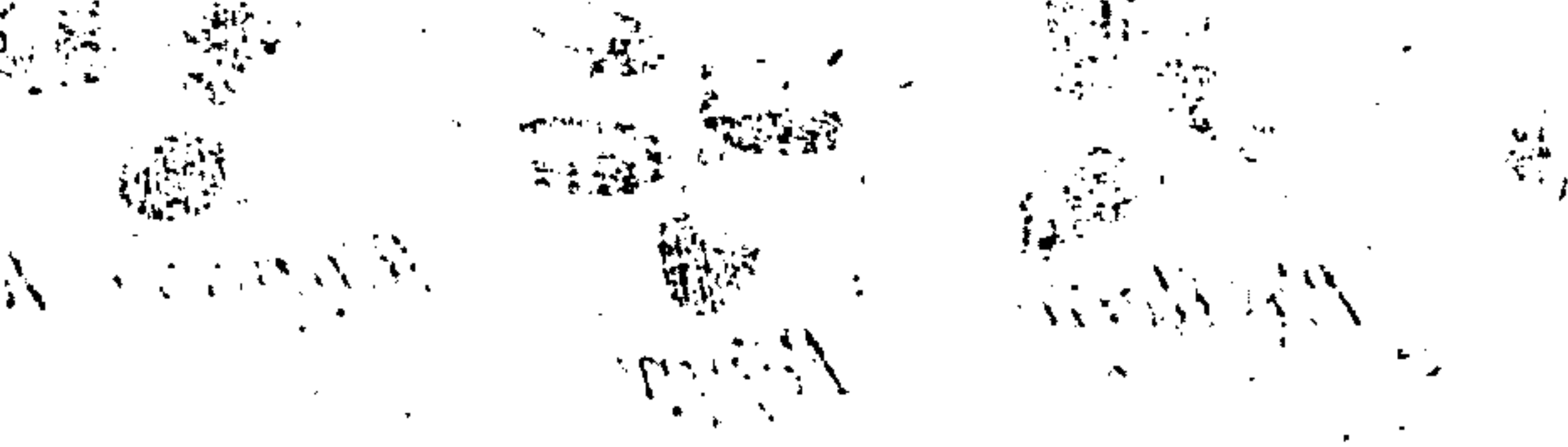
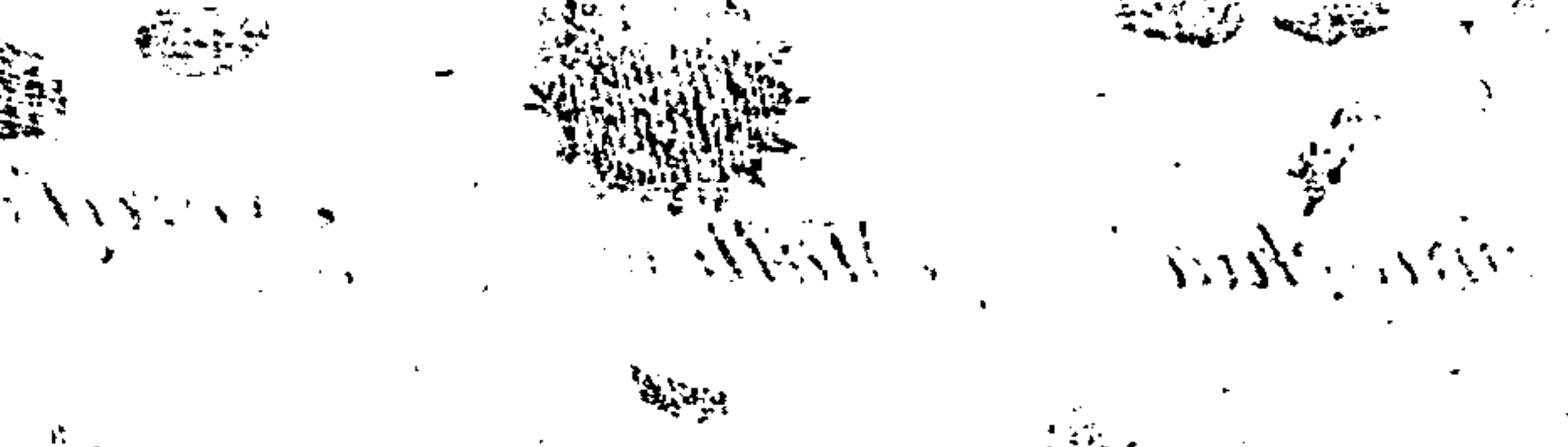
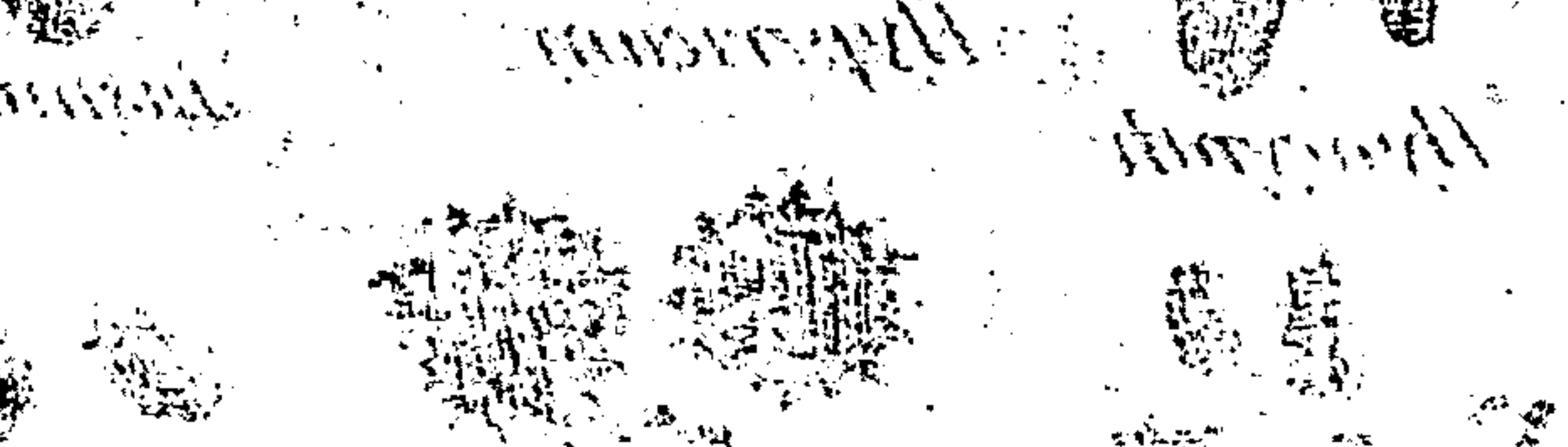
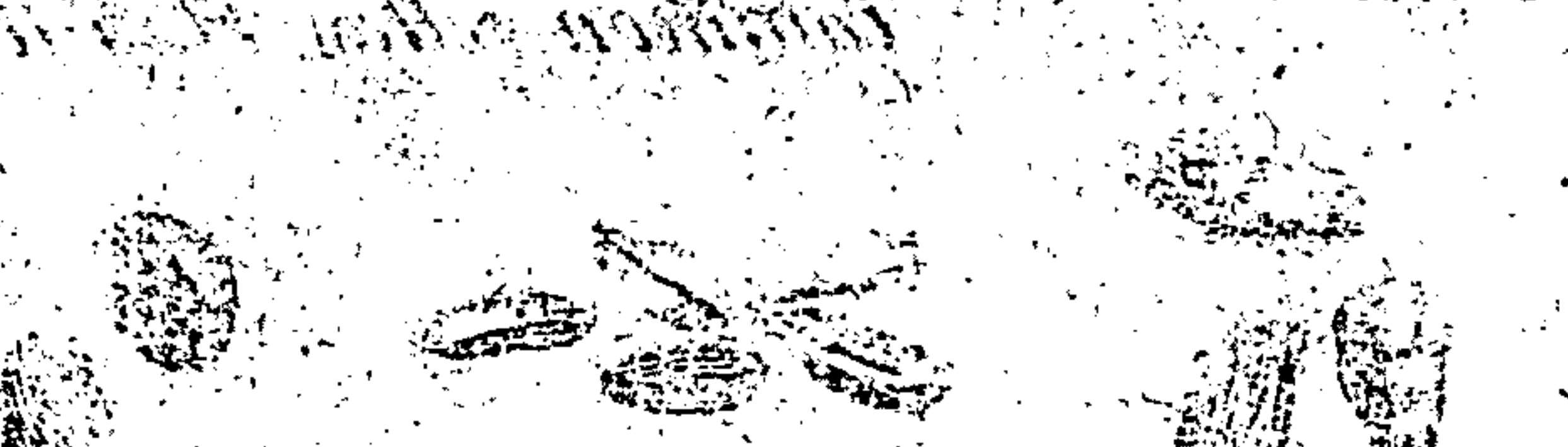




# MICROSCOPICAL OBJECTS

(PLATE II. Vegetable subjects.)

PLATE II. Vegetable subjects.





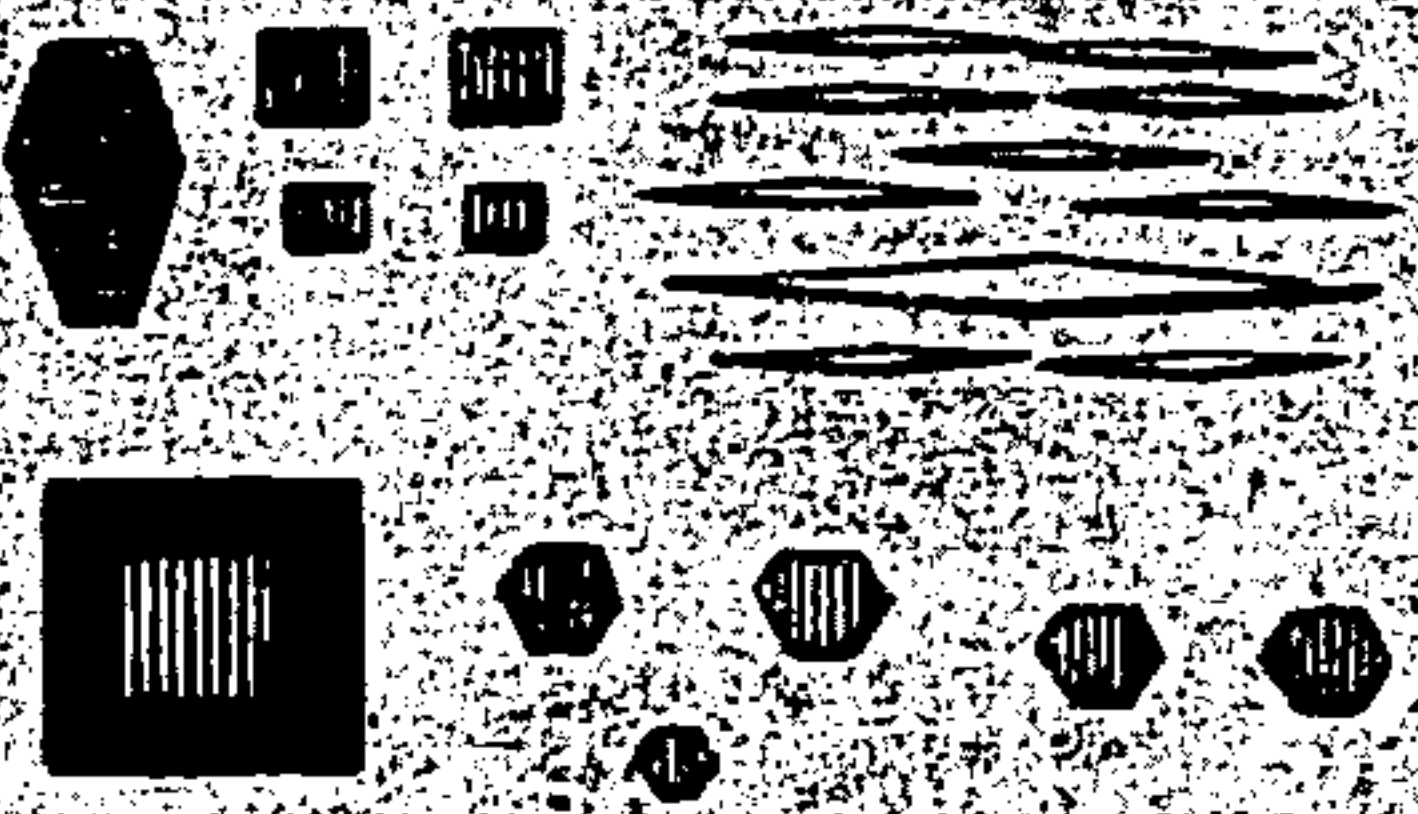
# MICROSCOPICAL OBJECTS

## CRYSTALLIZATIONS

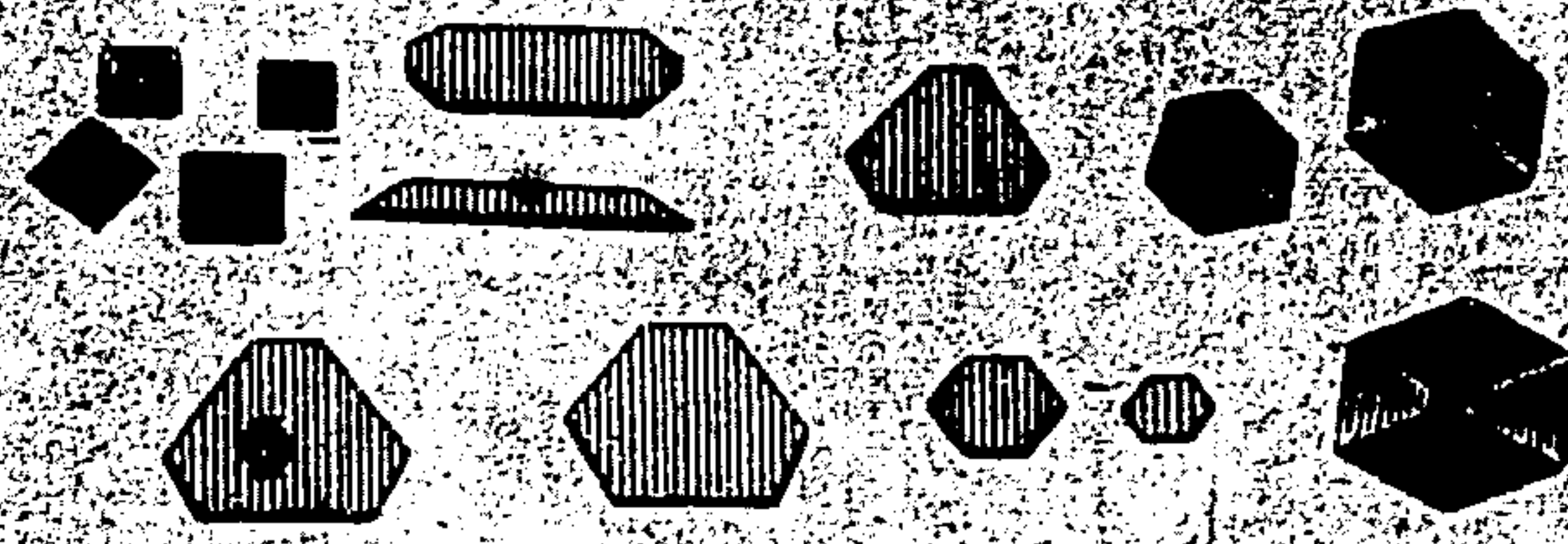
*From the Fixed Salt of  
Carduus Benedictus*



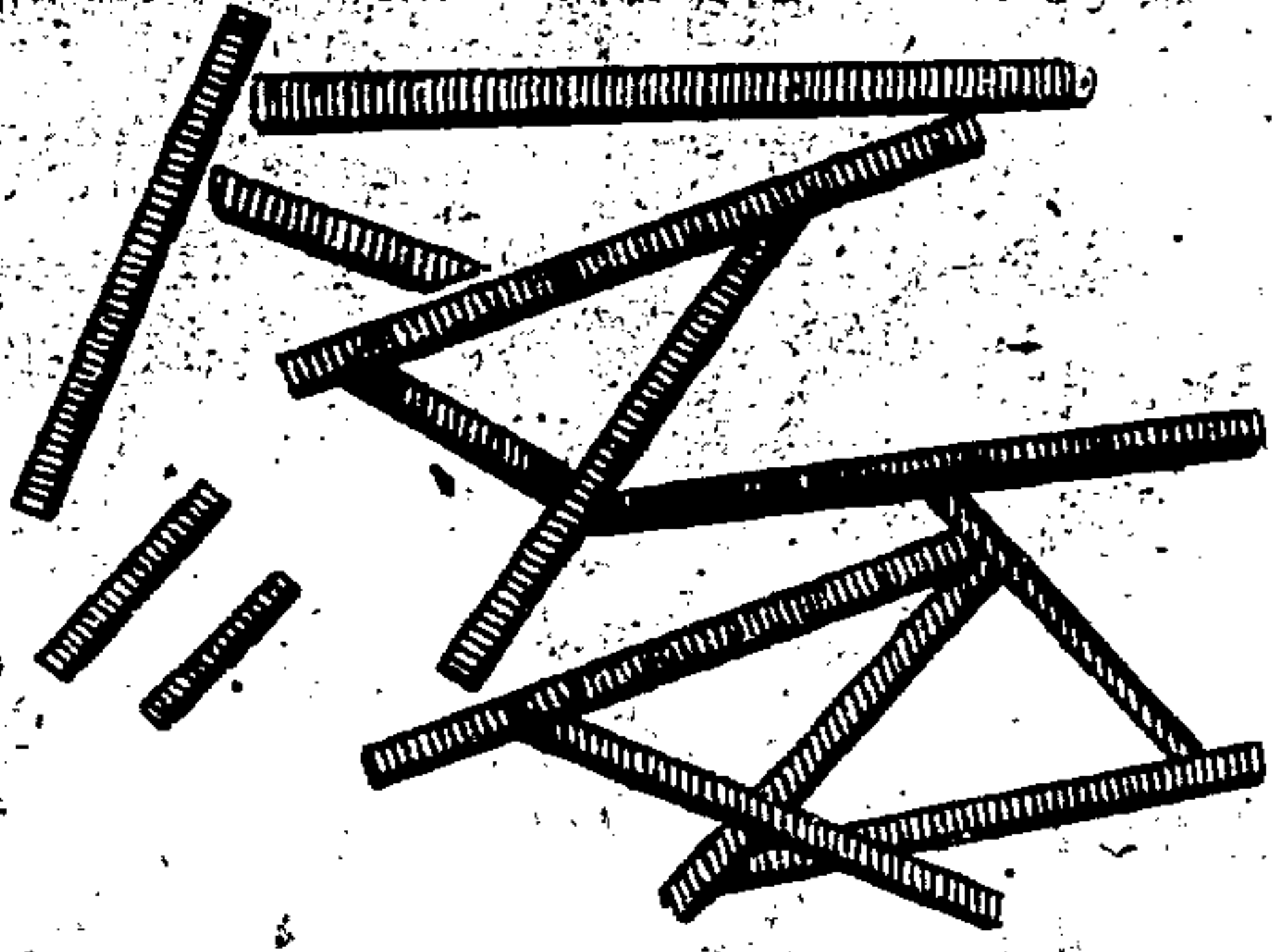
*From Salt of Wormwood*



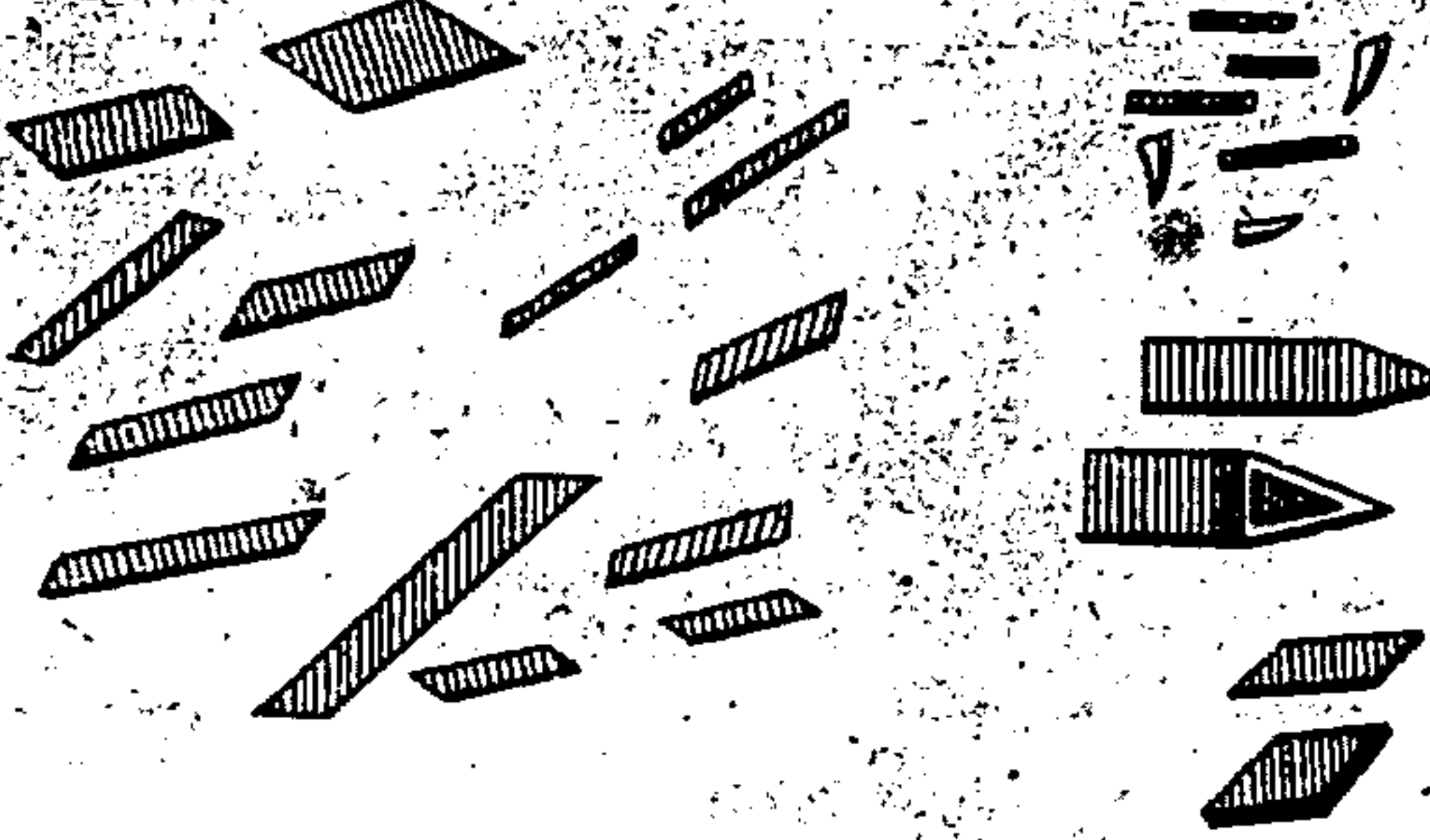
*From Allum*



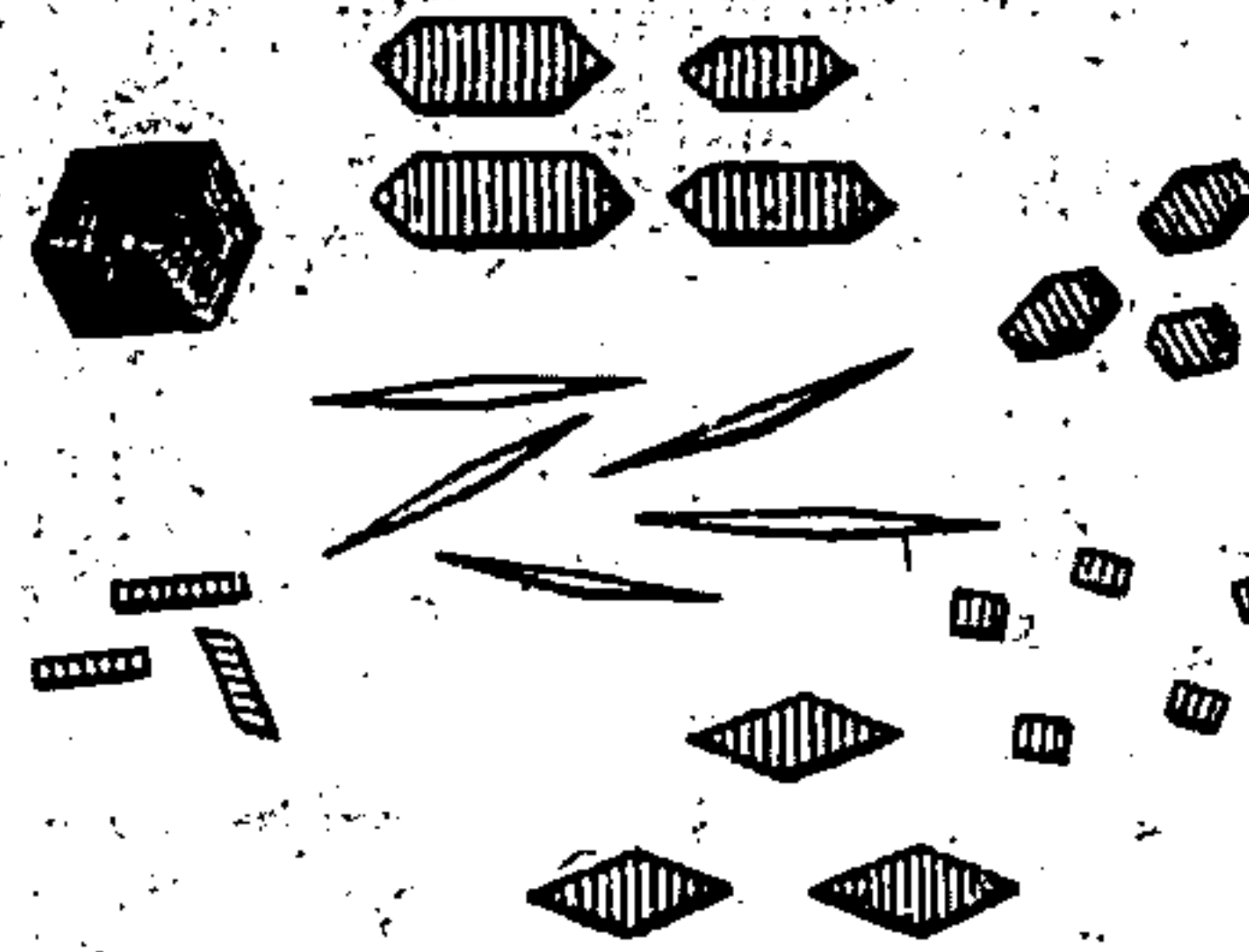
*From Nitre*



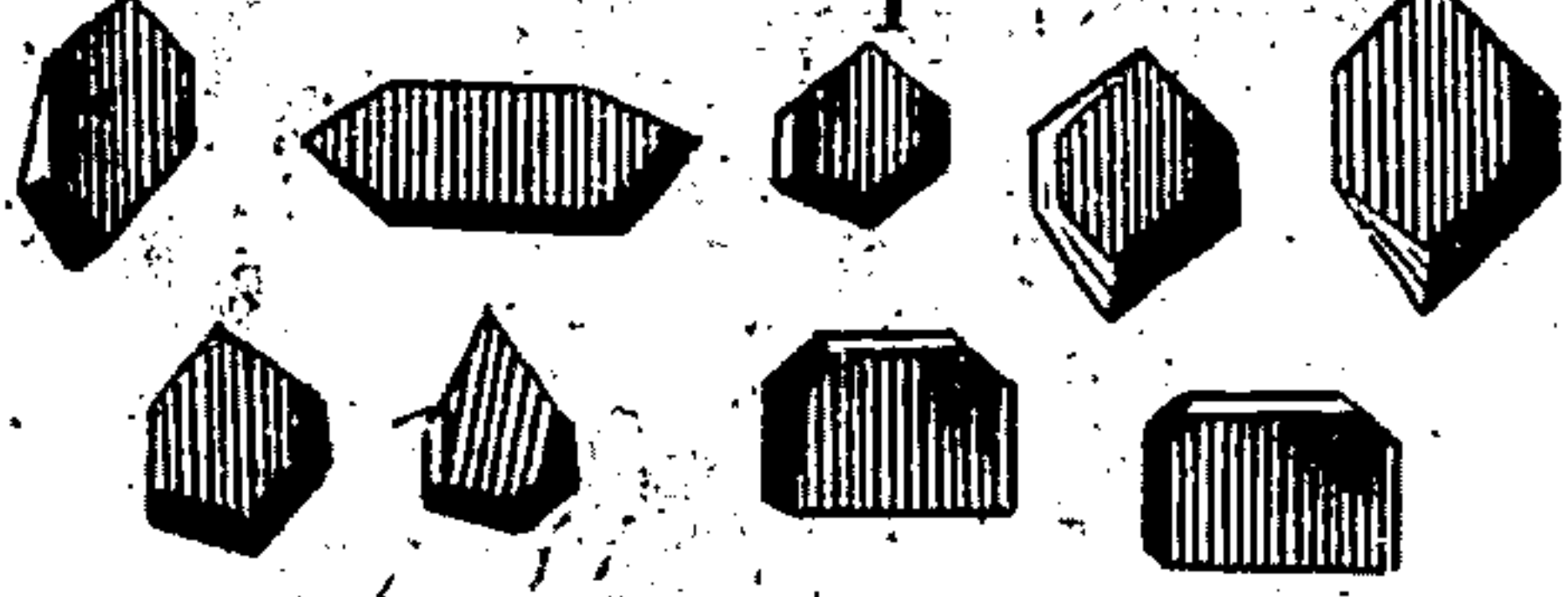
*From Blue Vitriol per deliquium*



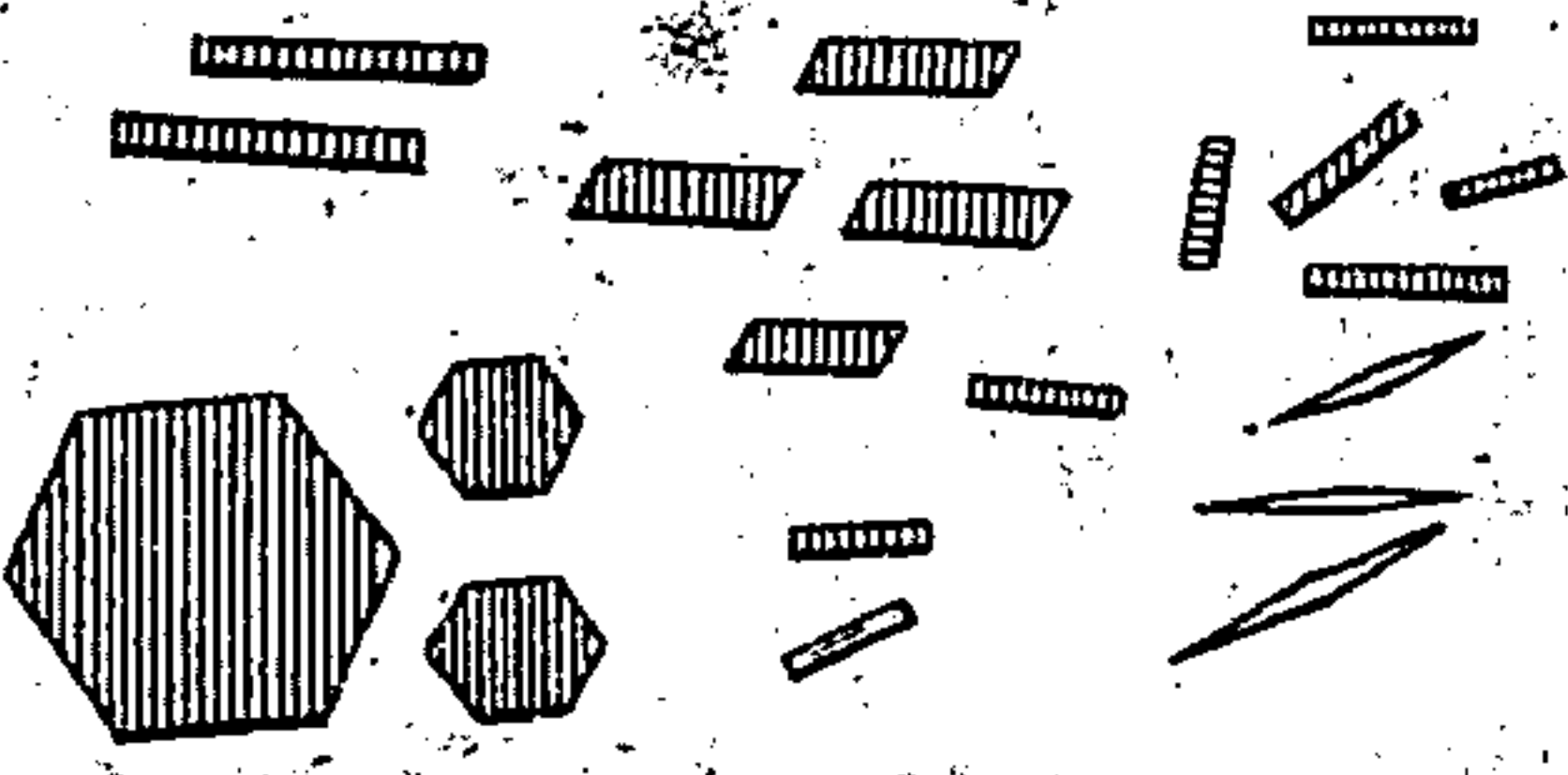
*From Potashes*



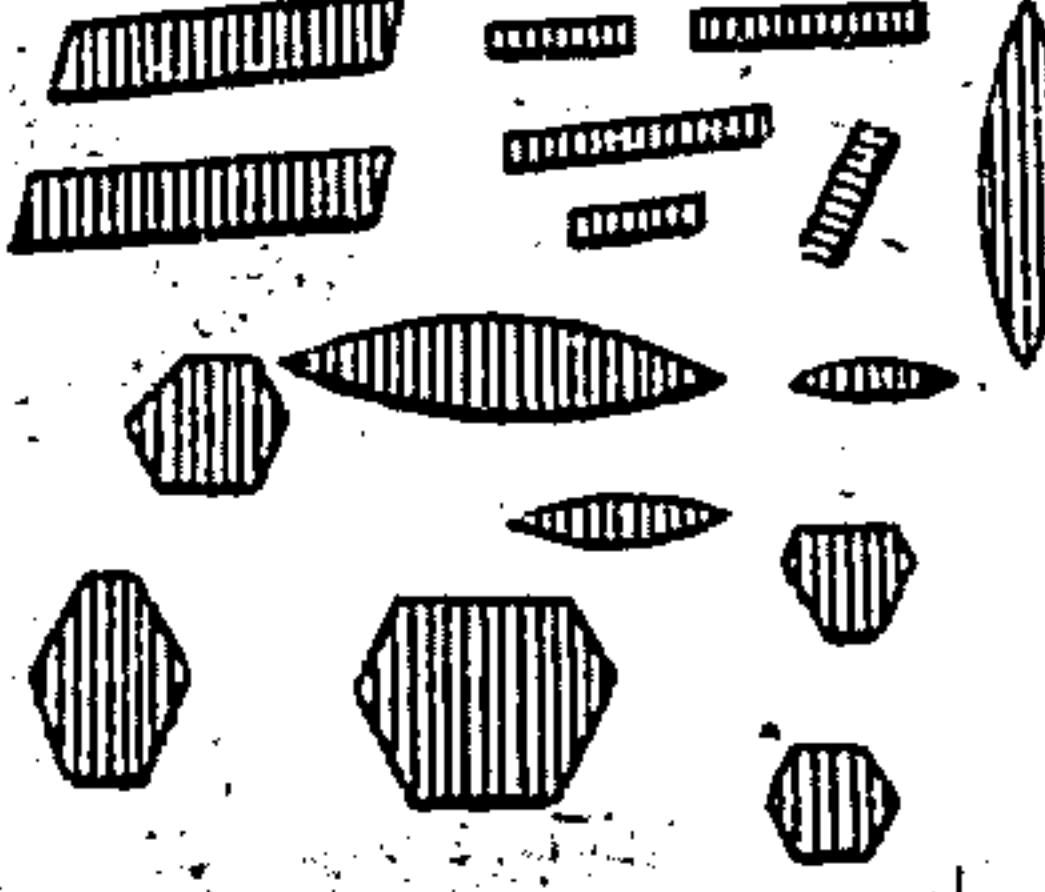
*From Camphire*



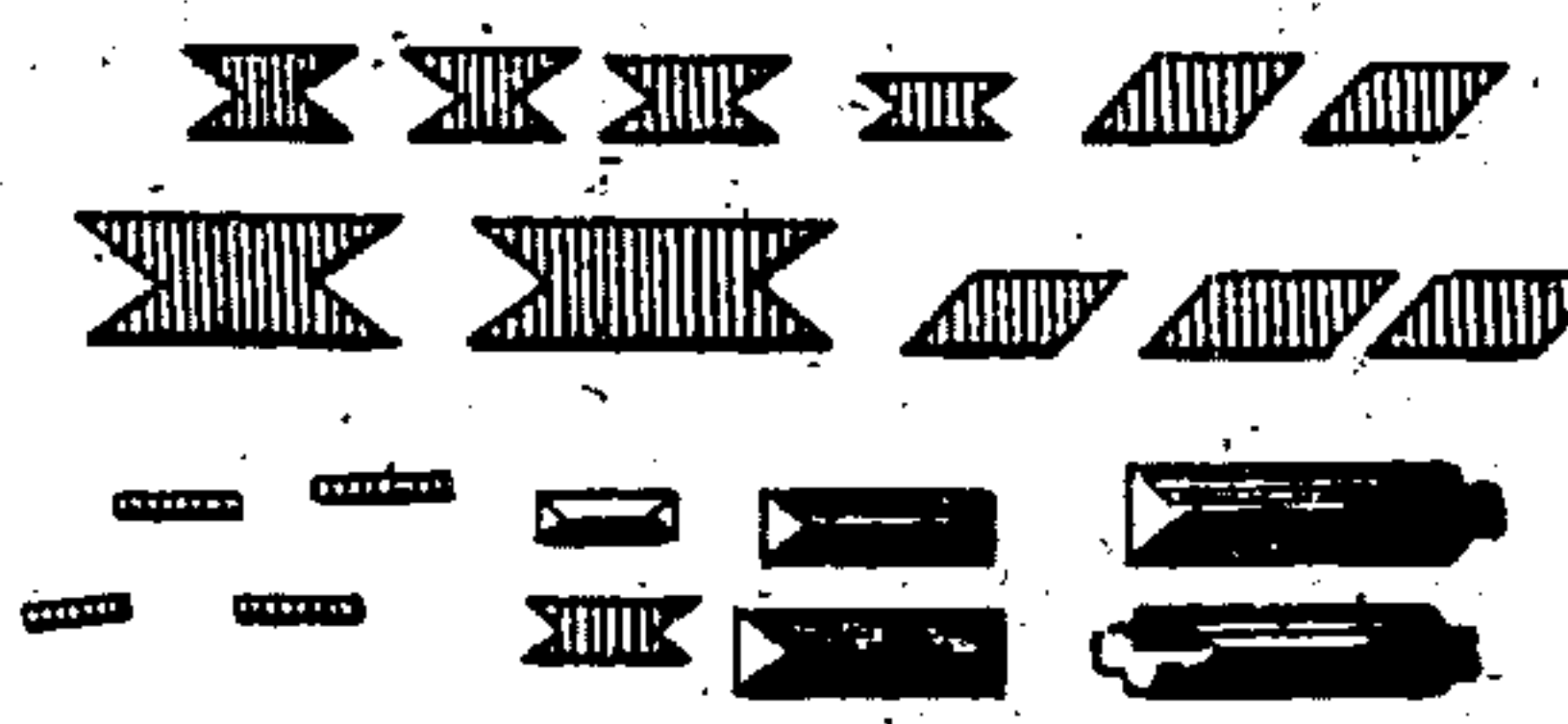
*From the Athes of  
Founderies of Metals*



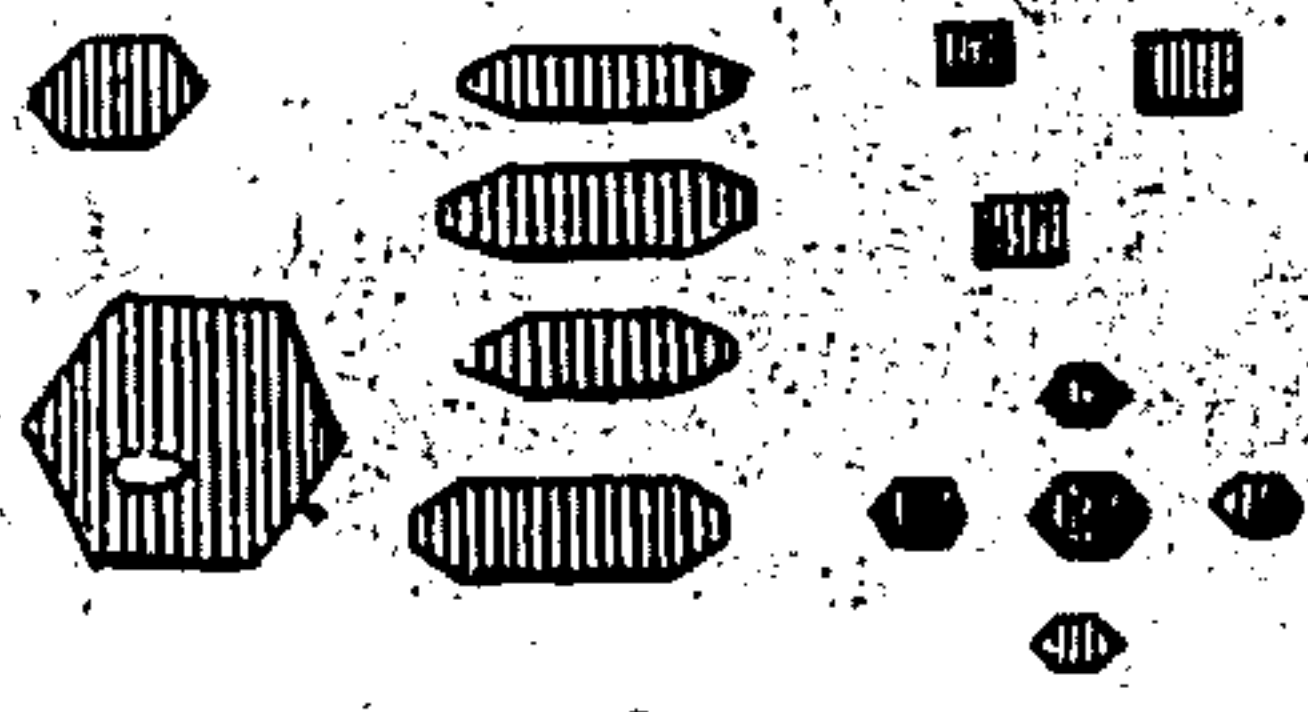
*From the Athes of  
Lead Furnaces*



*From the Soot of  
Lead Furnaces*



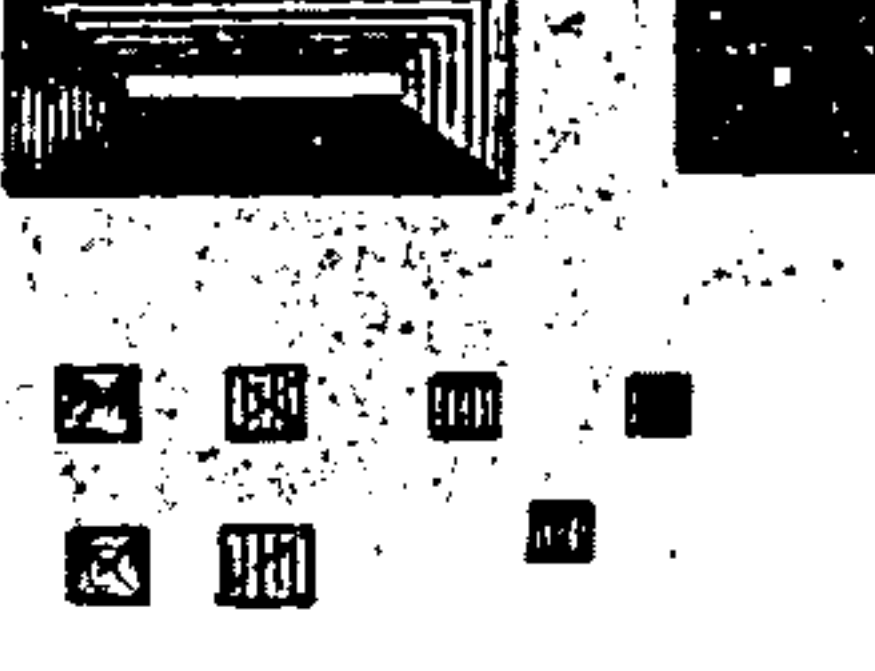
*From the Salt of  
Our Glaswort*



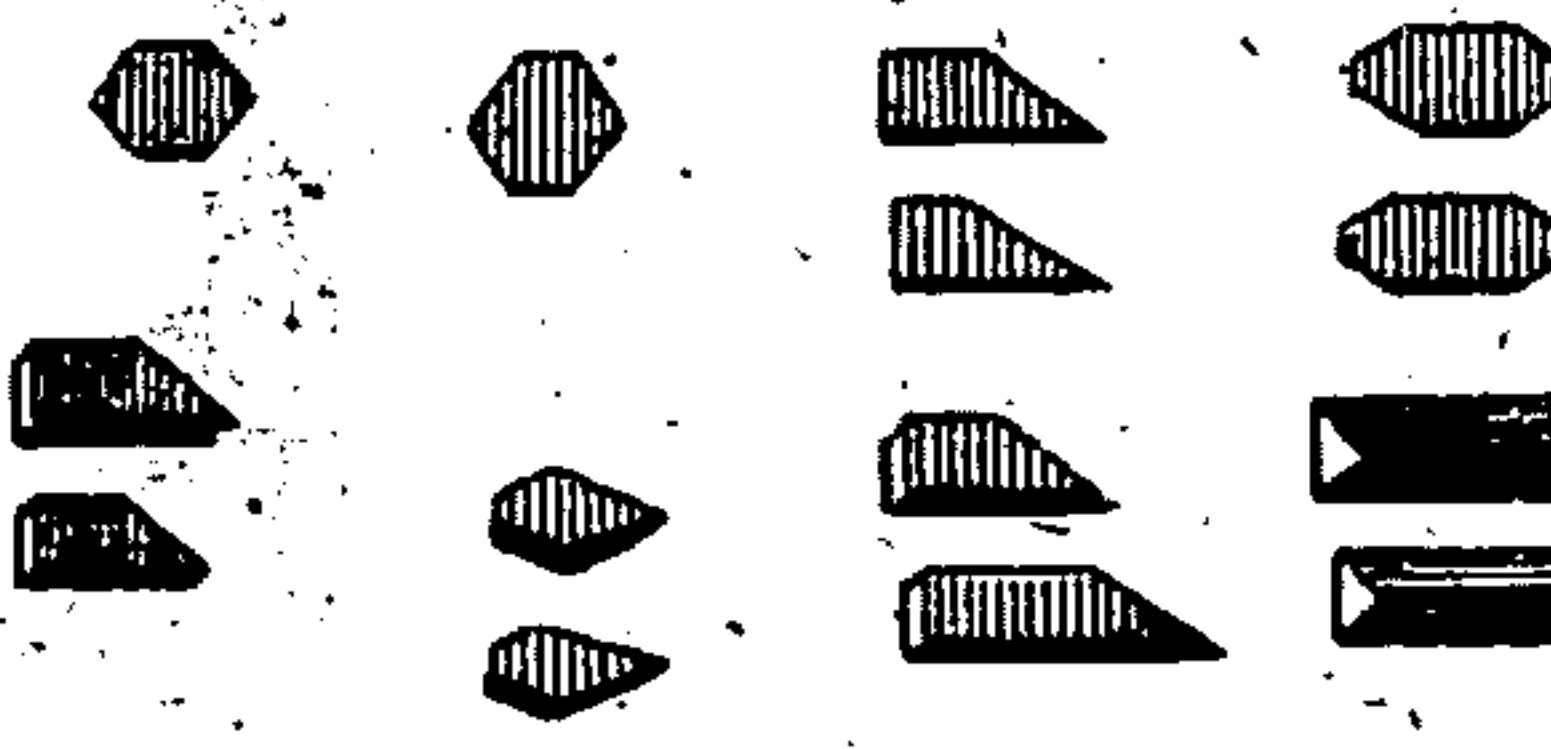
*From the Salt of  
Glaswort of Alicant*



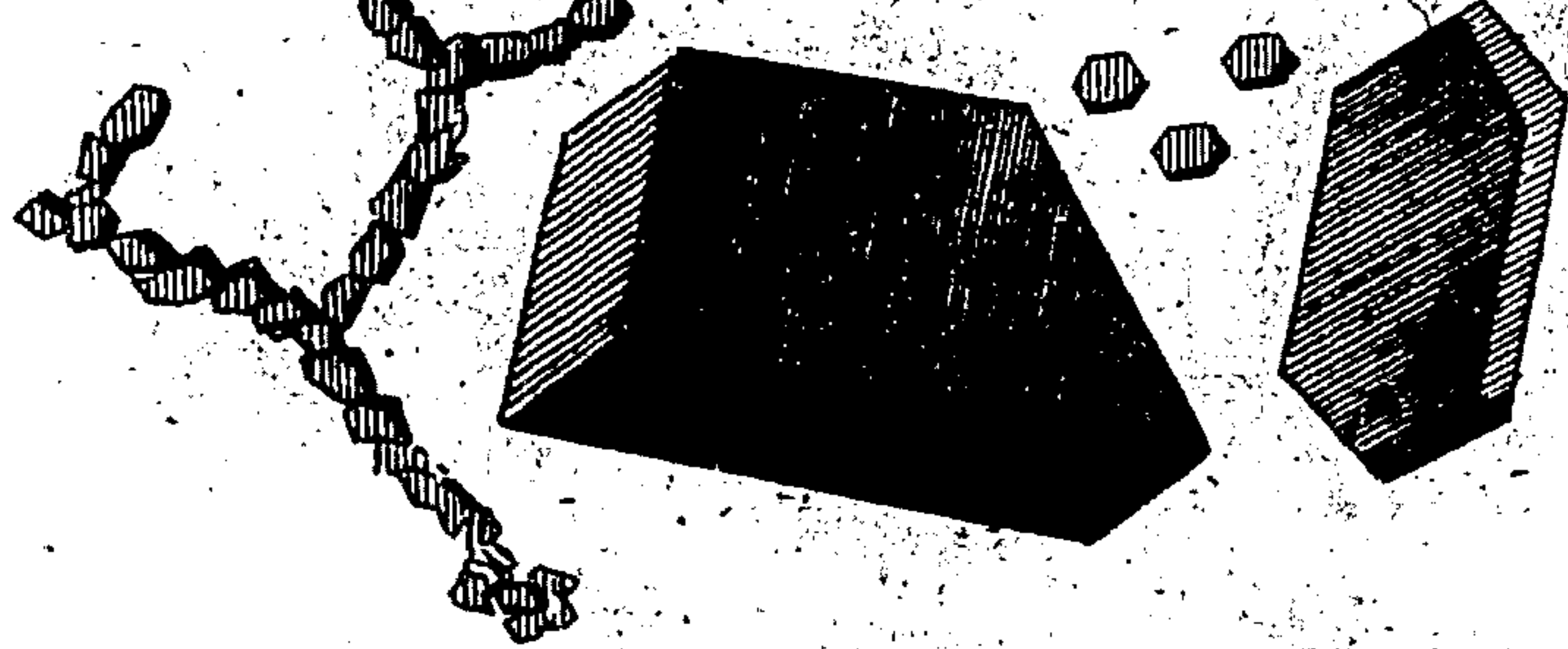
*From the Salt of  
Glaswort of Britany*



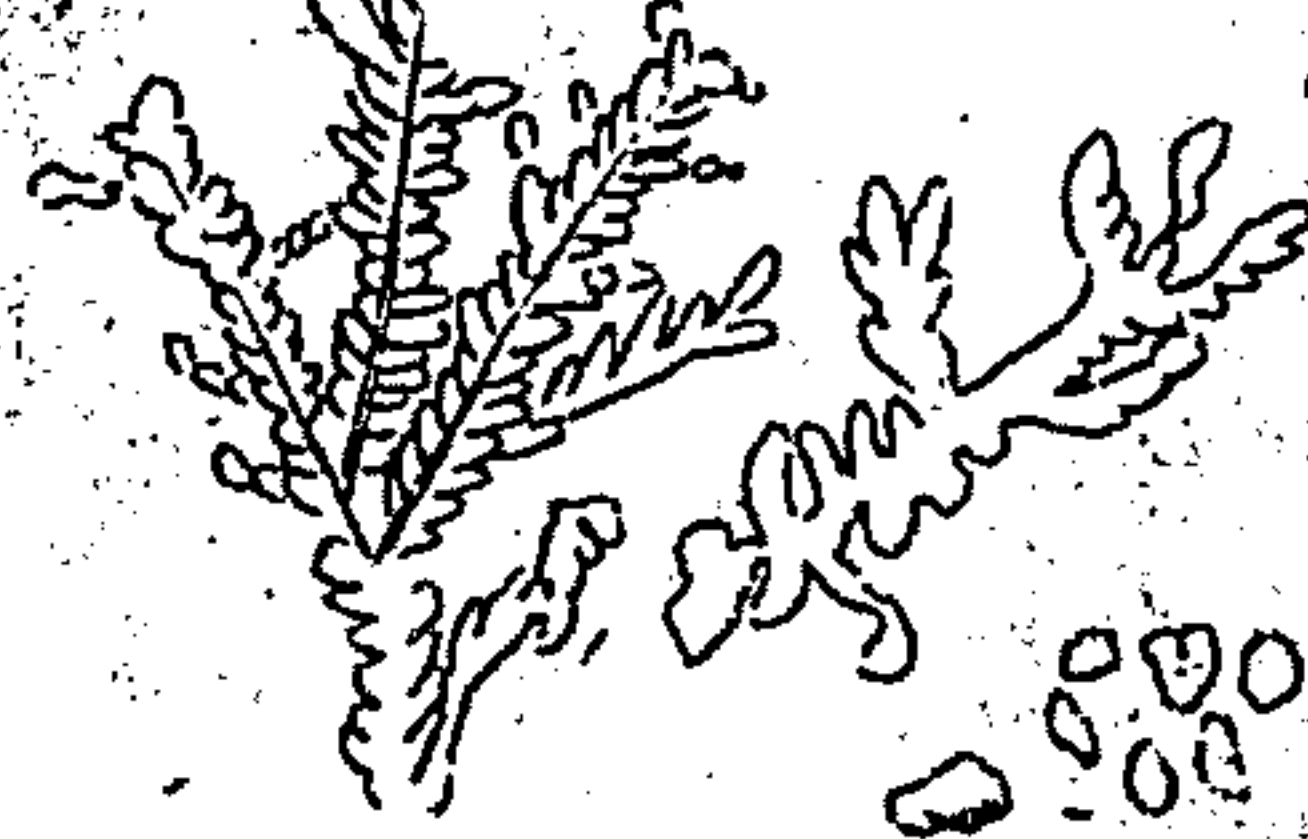
*From Quicklime*



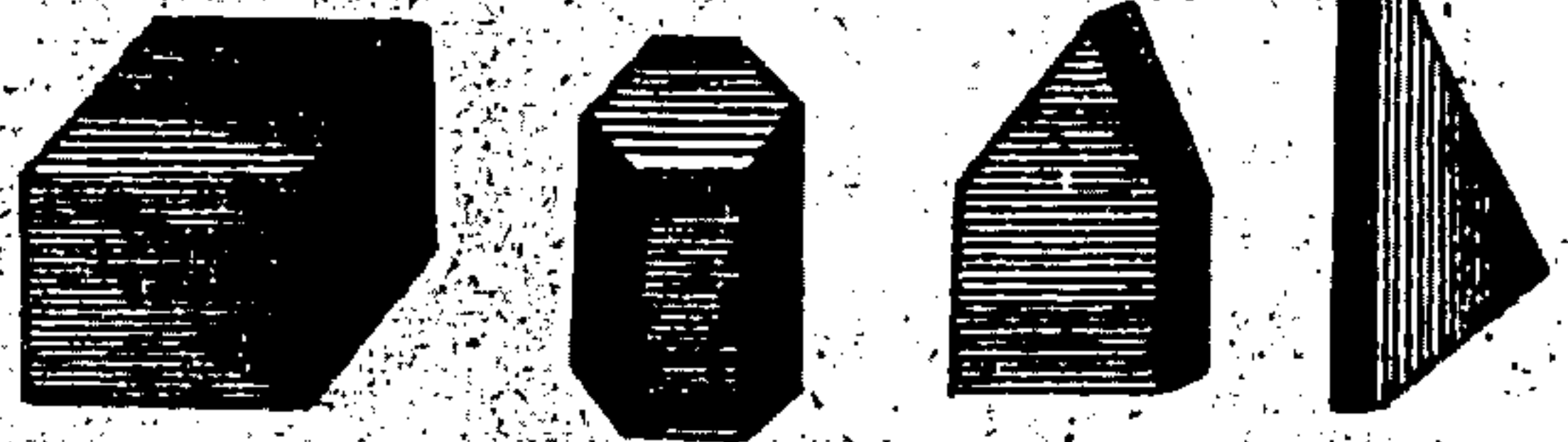
*From Quicklime made of Shells*



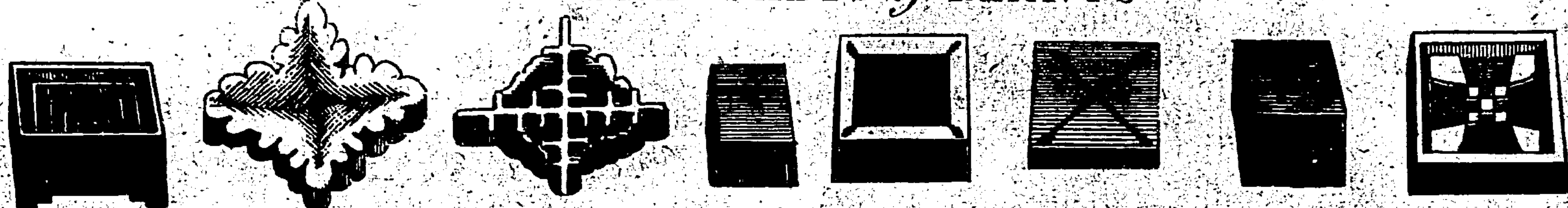
*From Sal Ammoniac*



*Constituent SALTS of Plants  
Marine Nitrous Alkaline Acid*



## MARINE SALTS of PLANTS



*Rosemary*

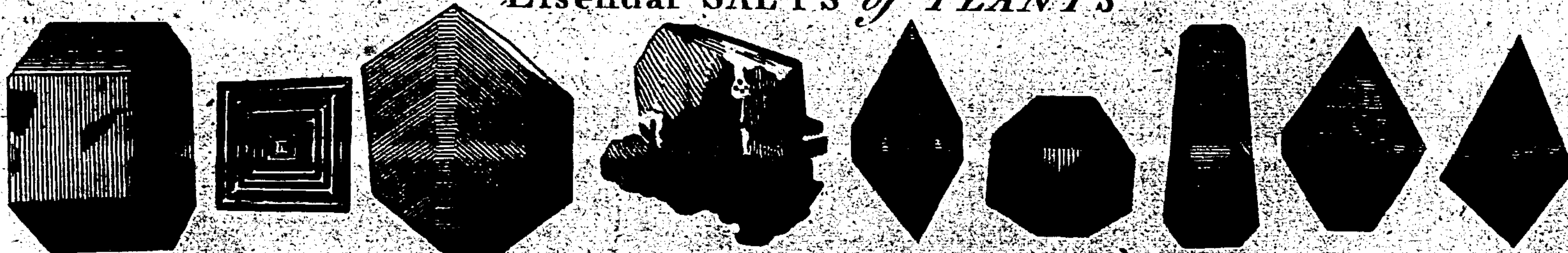
*Garden Scurvygrafs*

*Fern*

*Blackthorn*

*Wormwood*

## Essential SALTS of PLANTS



*From Common Sugar*

*Rosemary*

*Wormwood*

*Scurvygrafs*

*From SILVER dissolved in Aqua-fortis*



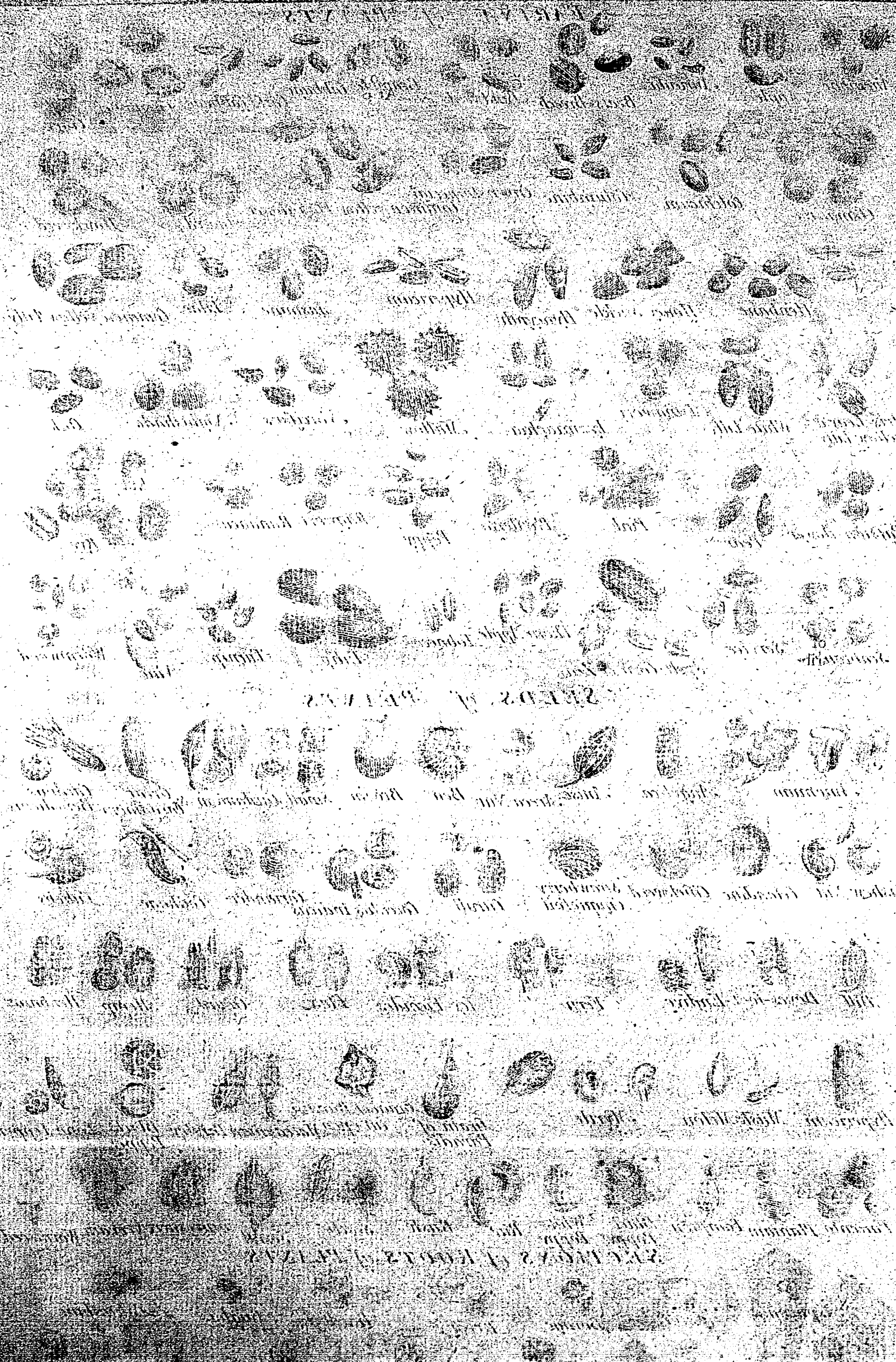


MICROSCOPICAL OBJECTS

PLATE I. 1831

PLATE II. 1831

PLATE III. 1831

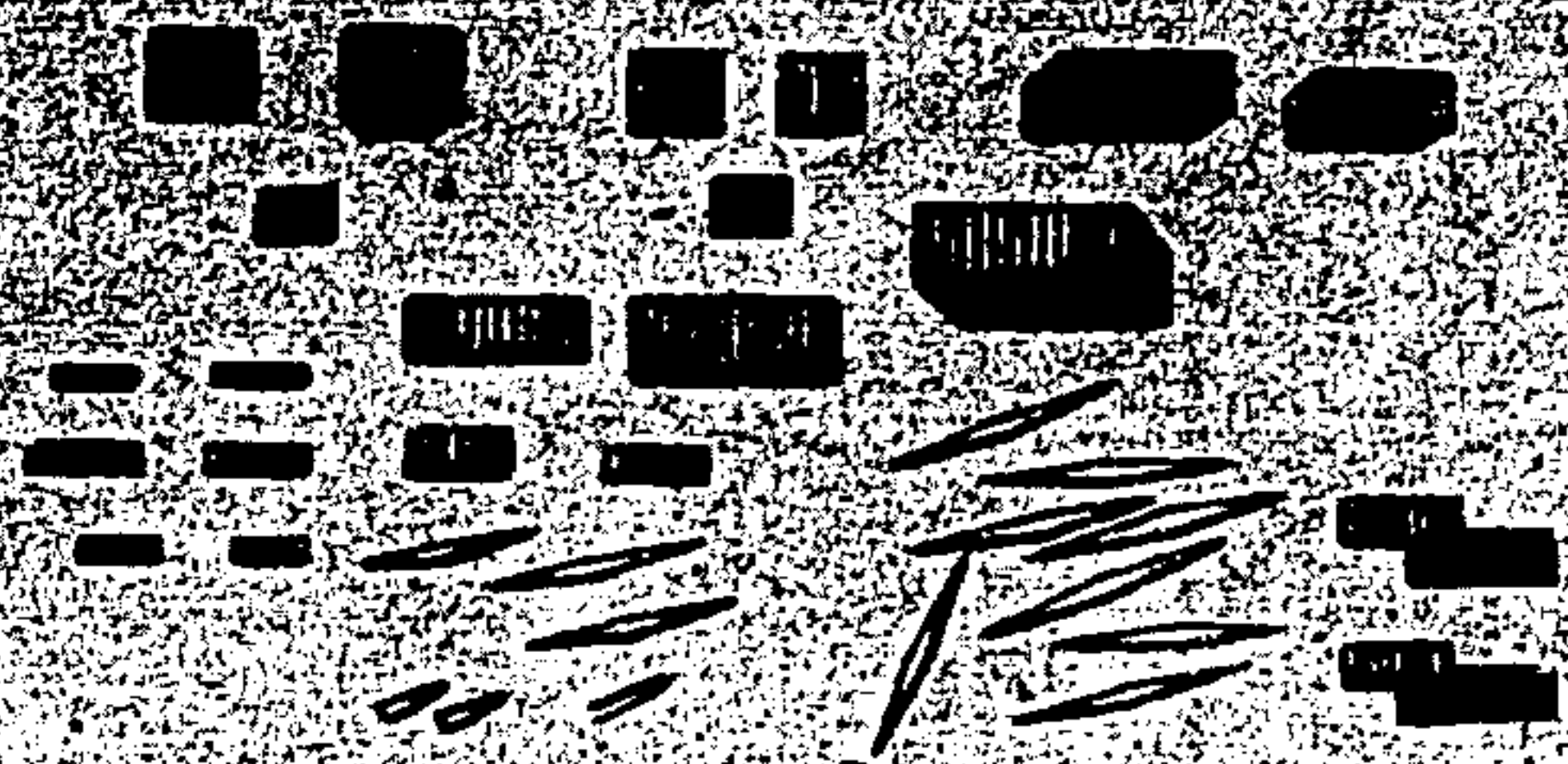




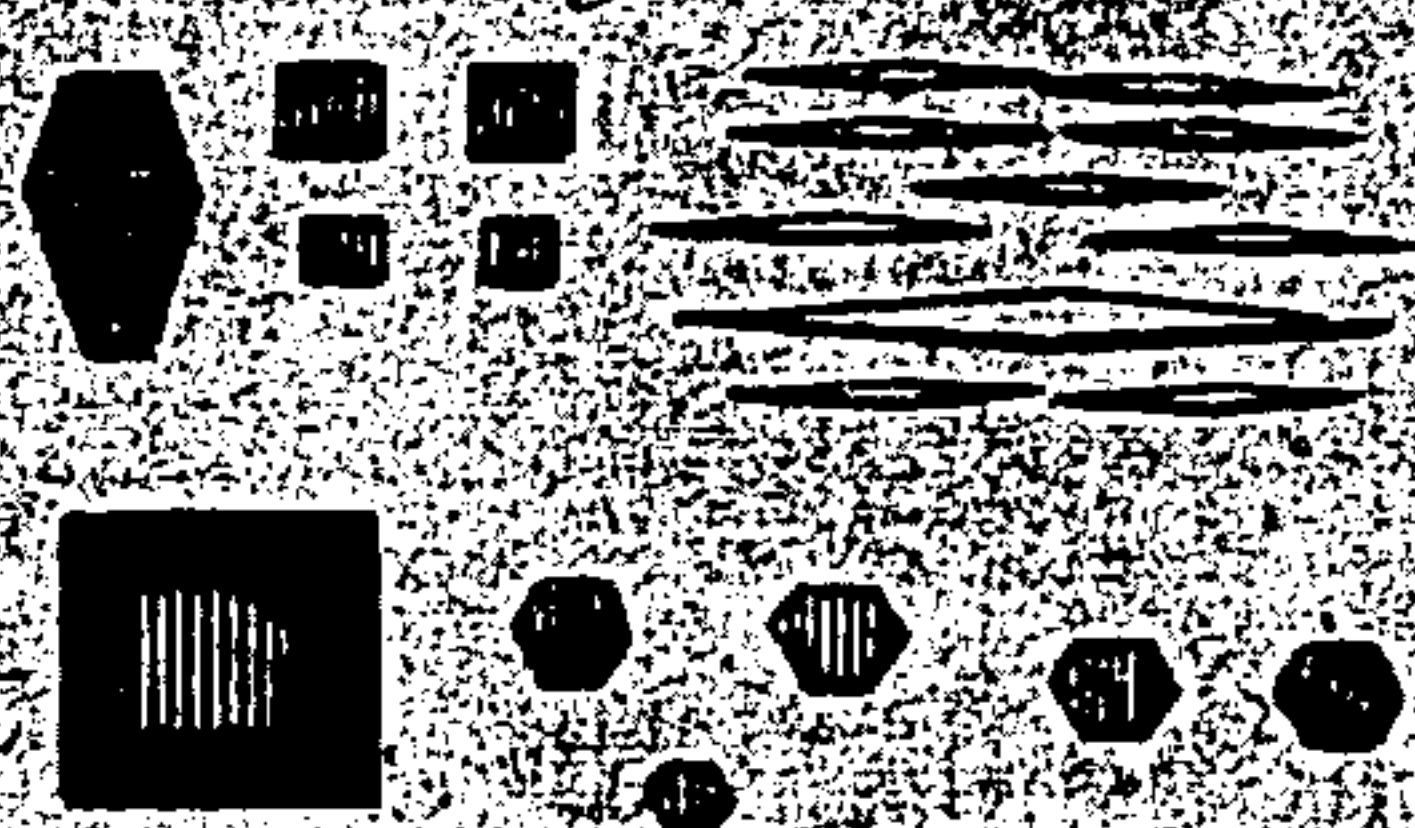
# MICROSCOPICAL OBJECTS

## CRYSTALLIZATIONS

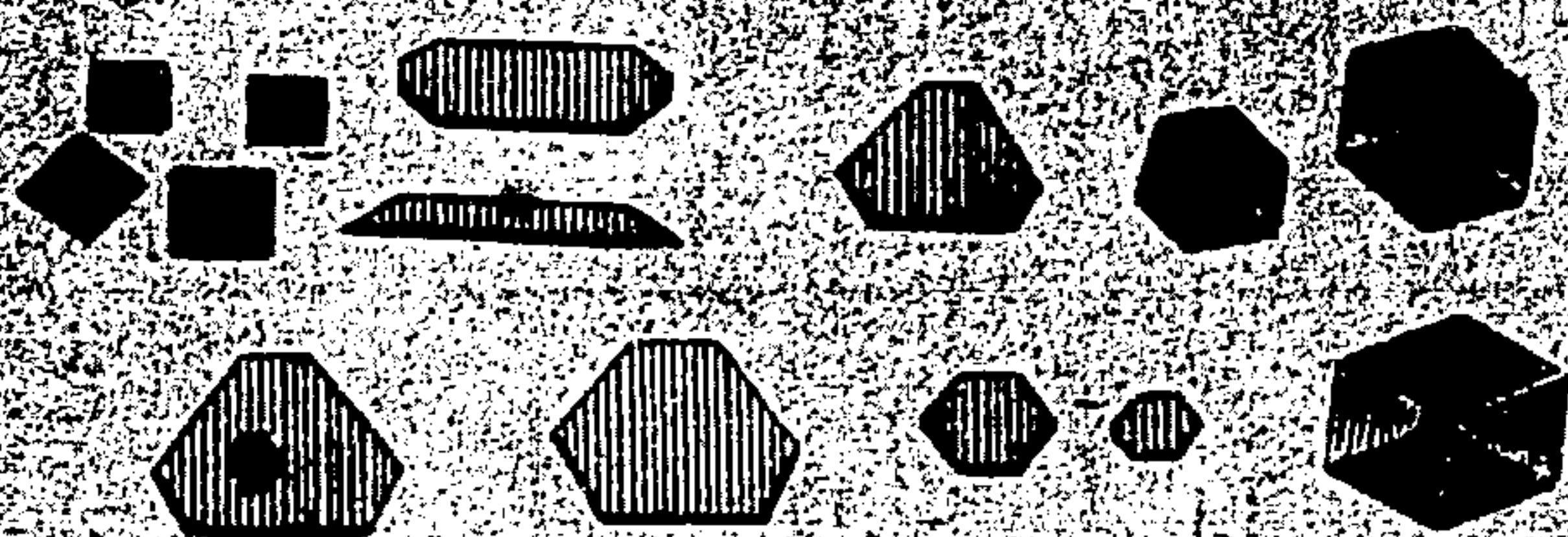
*From the Fixed Salt of  
Carduus Benedictus*



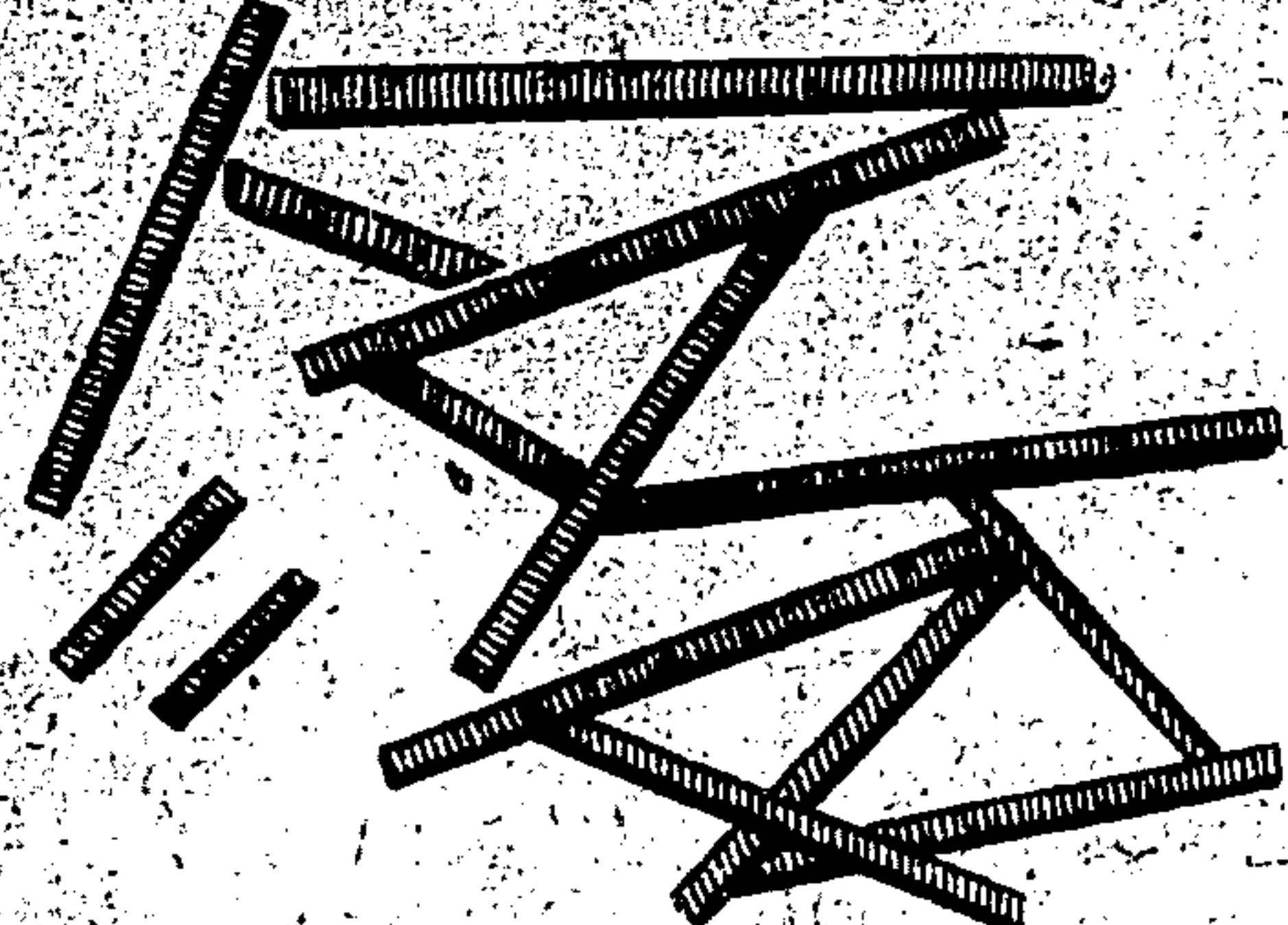
*From Salt of Wormwood*



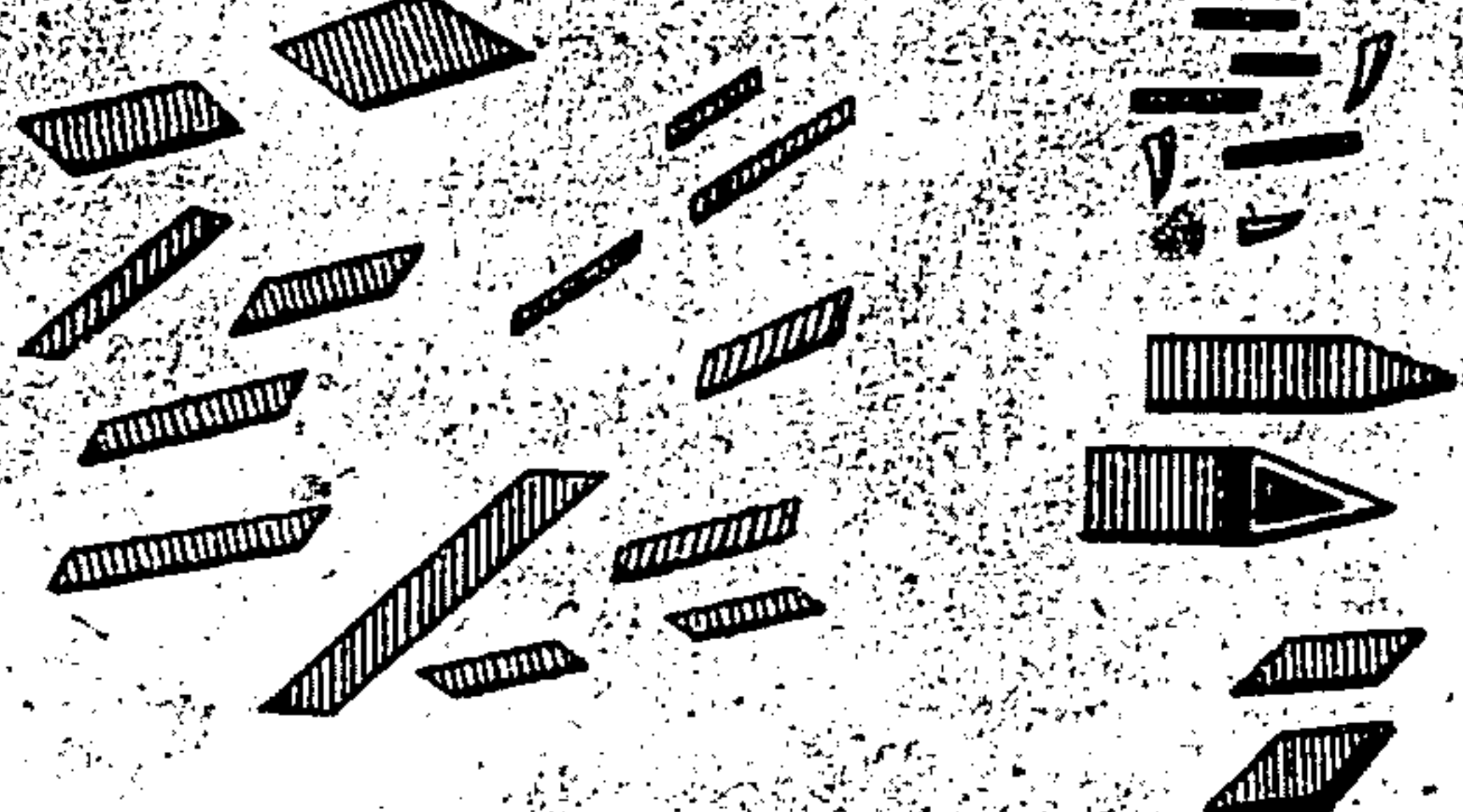
*From Allum*



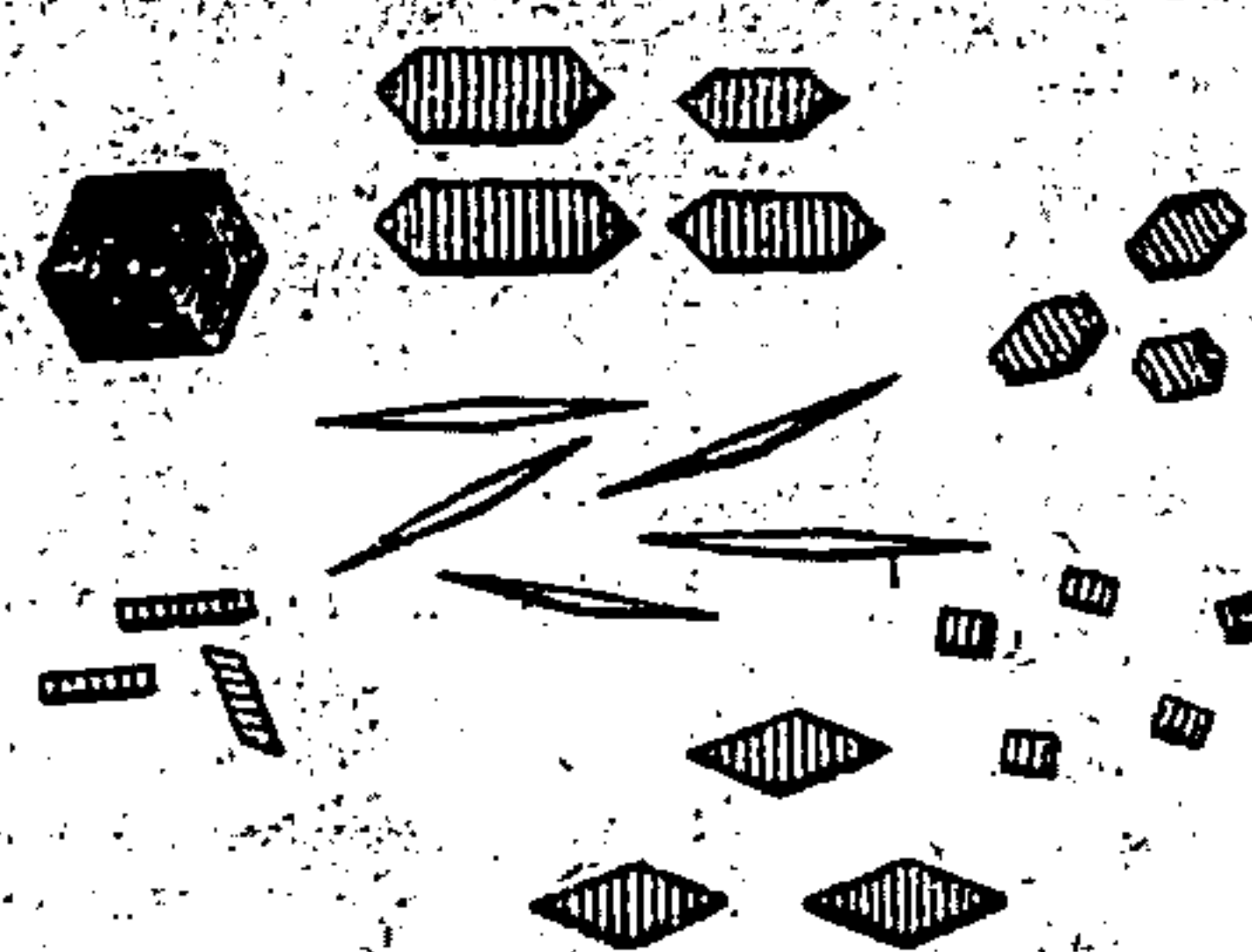
*From Nitre*



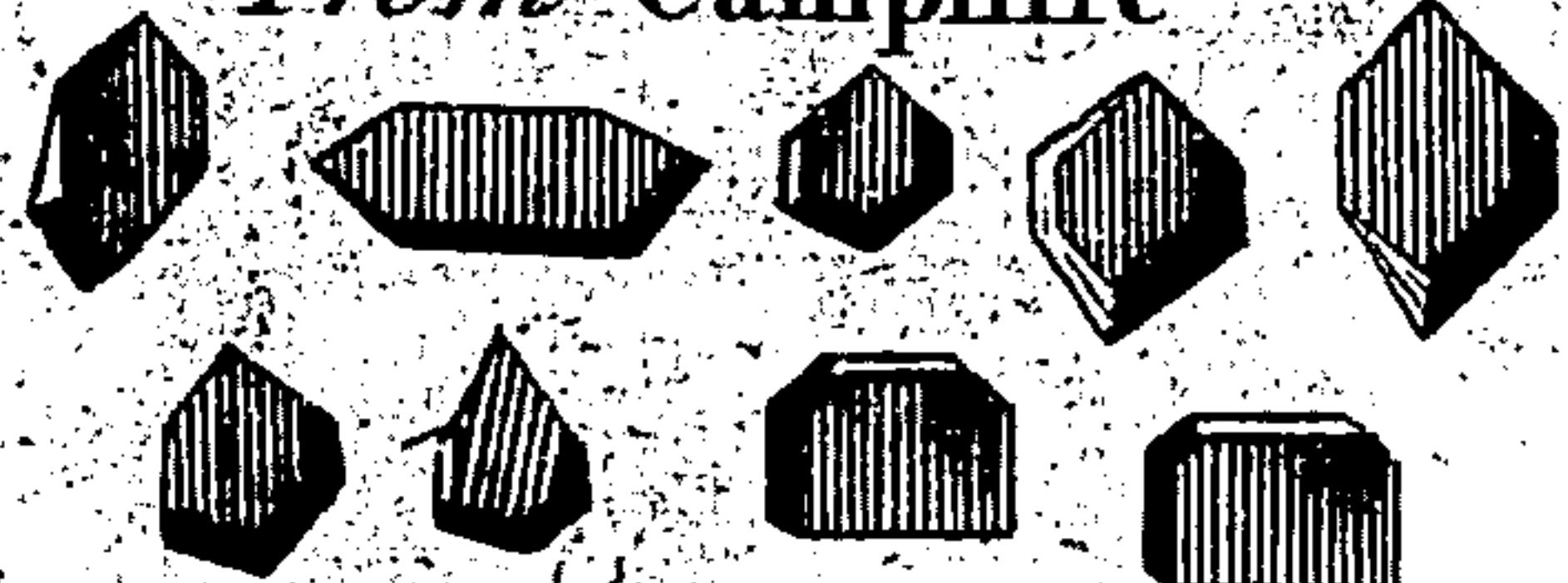
*From Blue Vitriol* *From Oil of Tartar  
per deliquium*



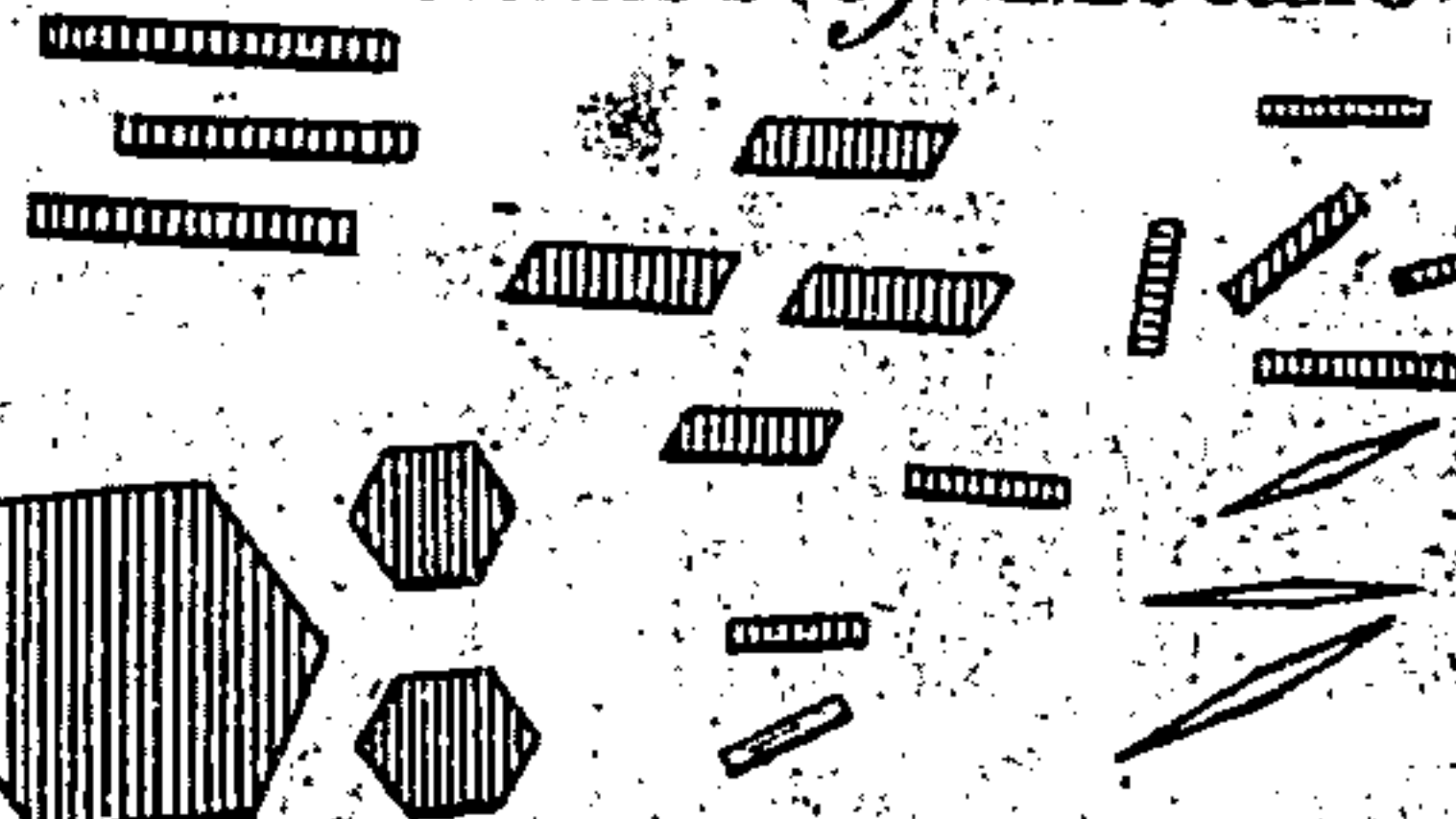
*From Potashes*



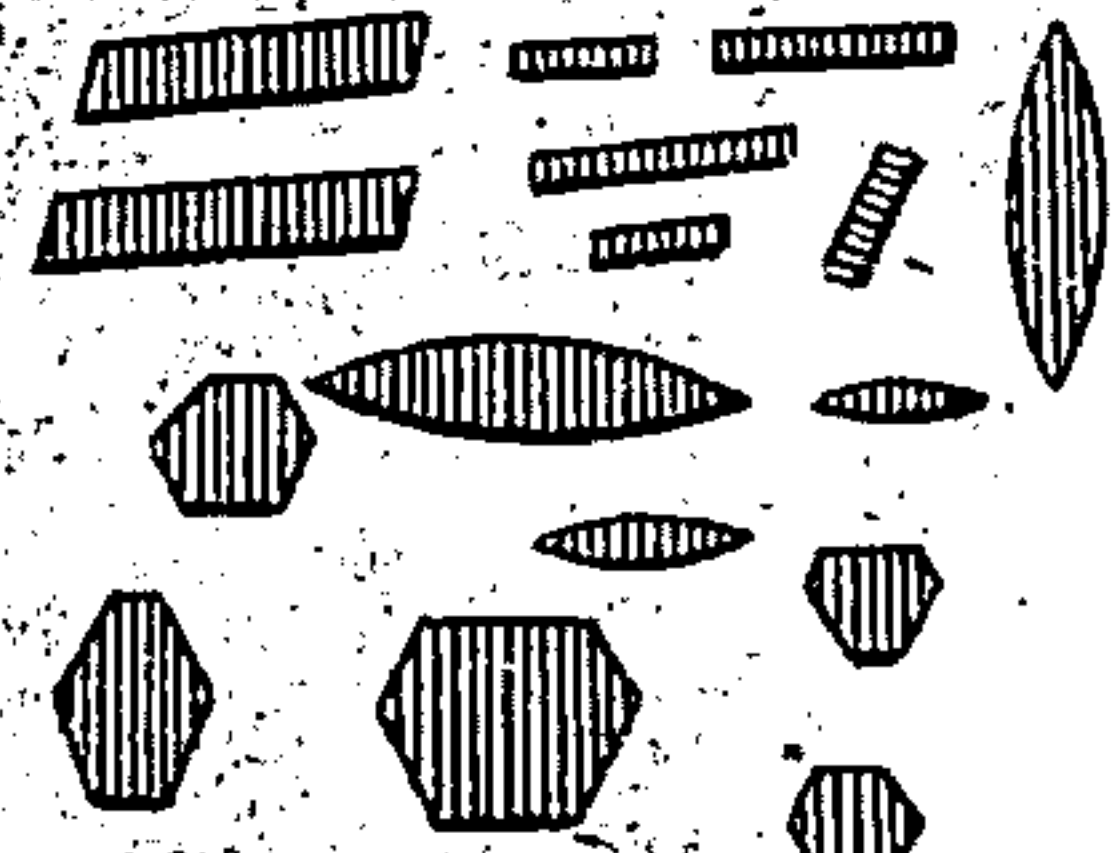
*From Camphire*



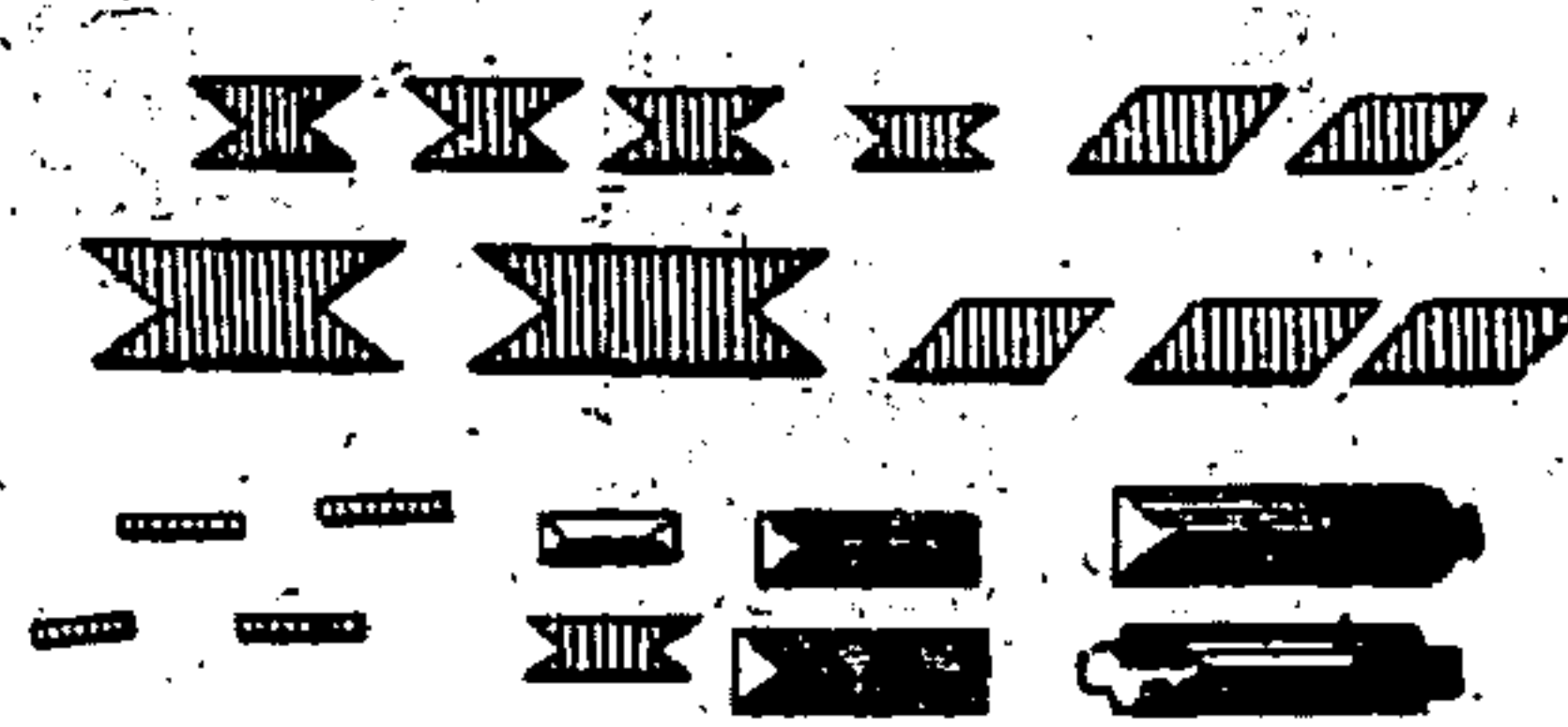
*From the Ashes of  
Founderies of Metals*



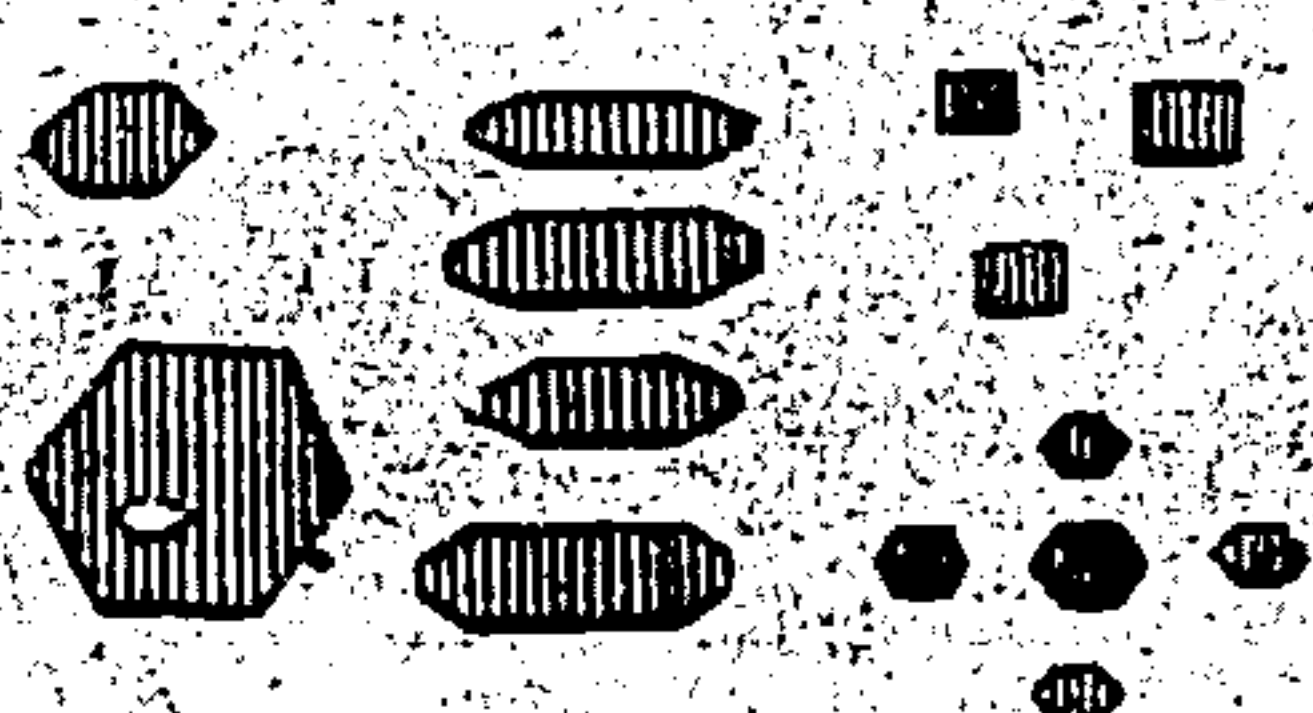
*From the Ashes of  
Lead Furnaces*



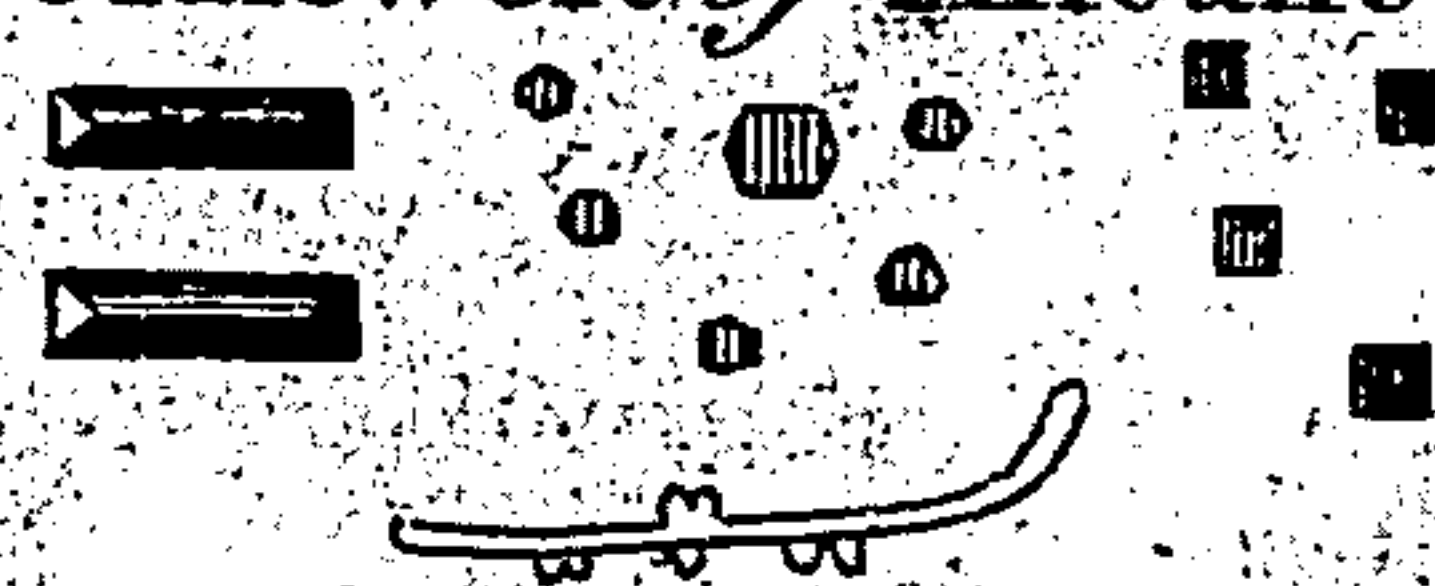
*From the Soot of  
Lead Furnaces*



*From the Salt of  
Our Glaswort*



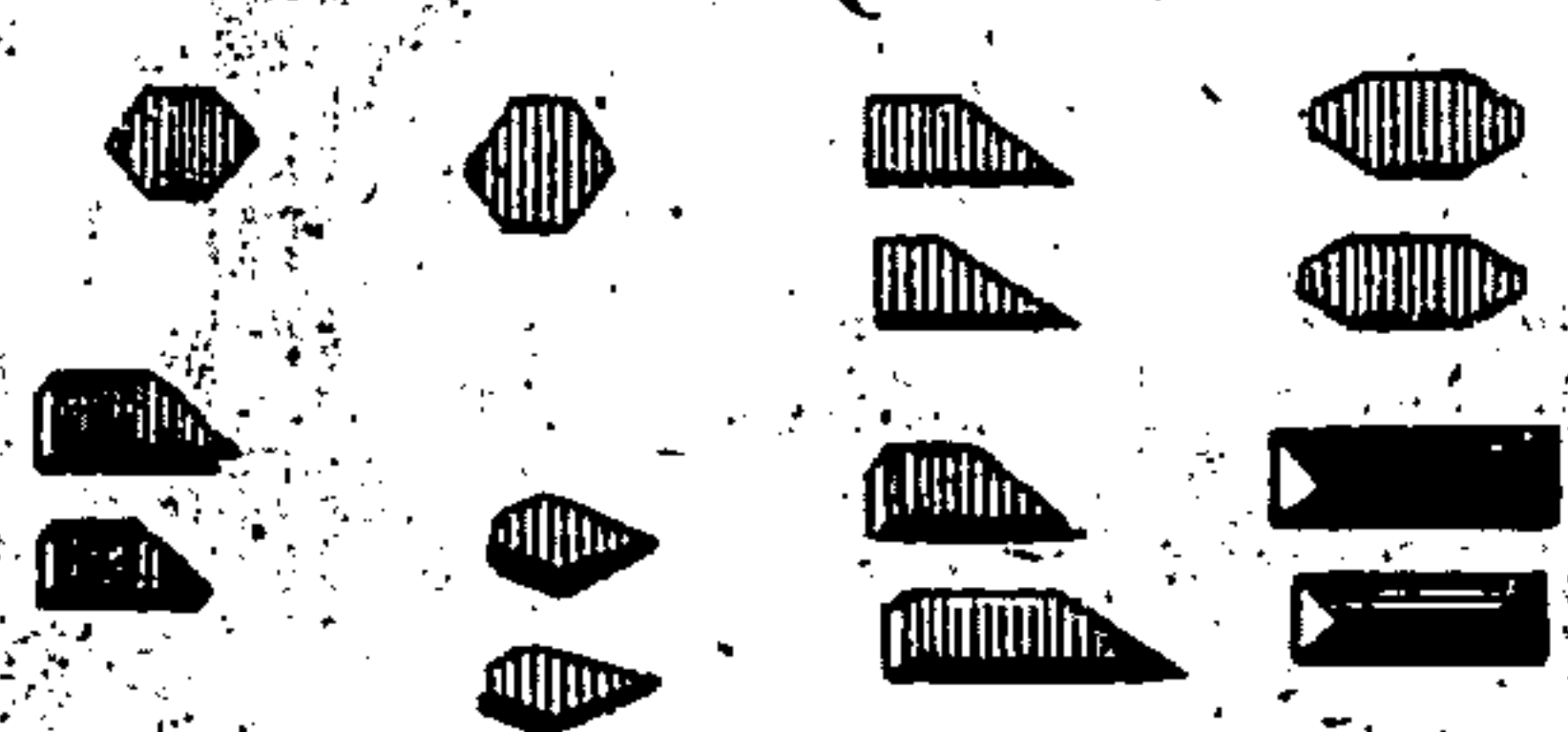
*From the Salt of  
Glaswort of Alicant*



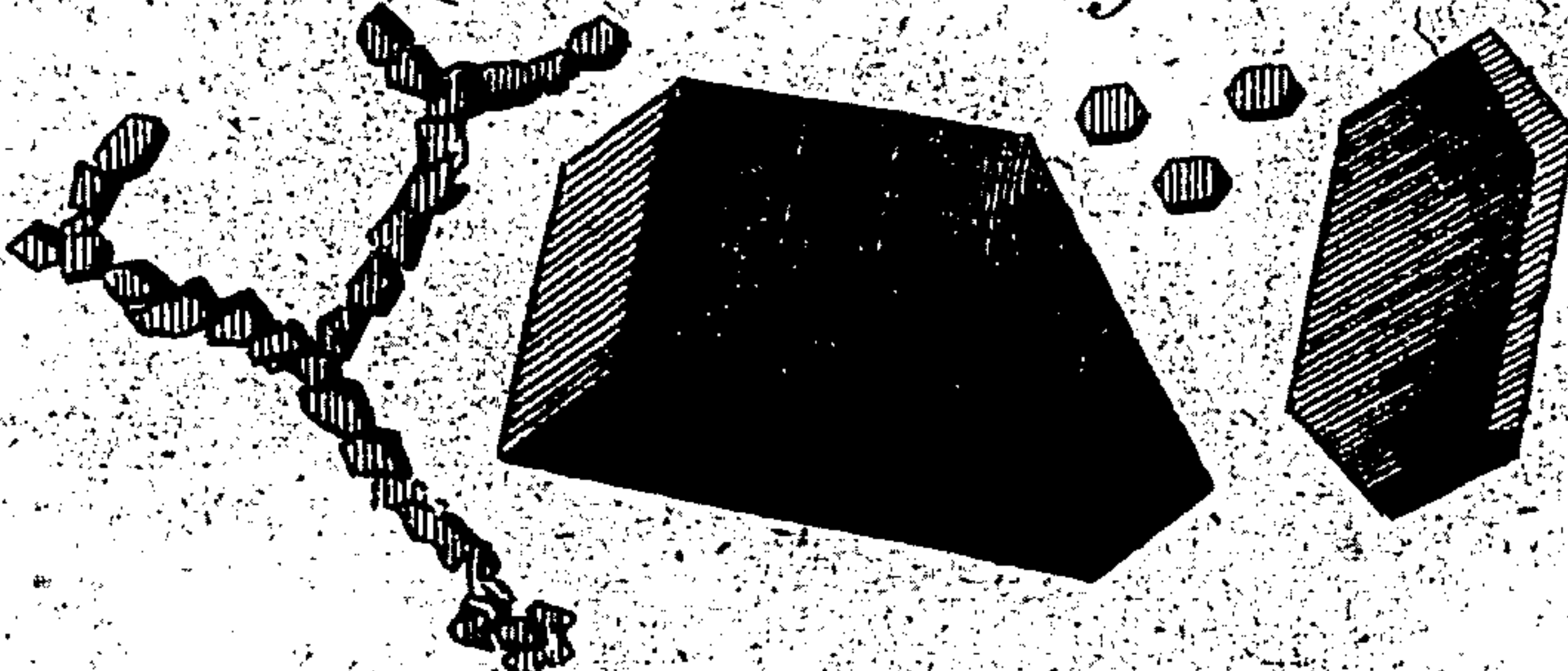
*From the Salt of  
Glaswort of Britany*



*From Quicklime*



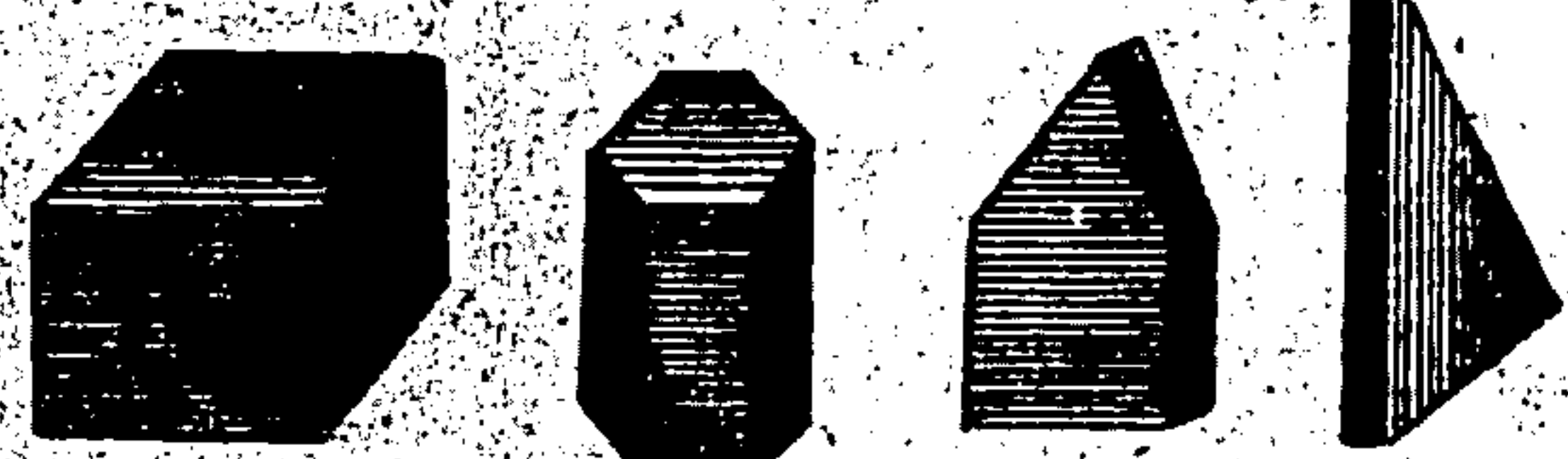
*From Quicklime made of Shells*



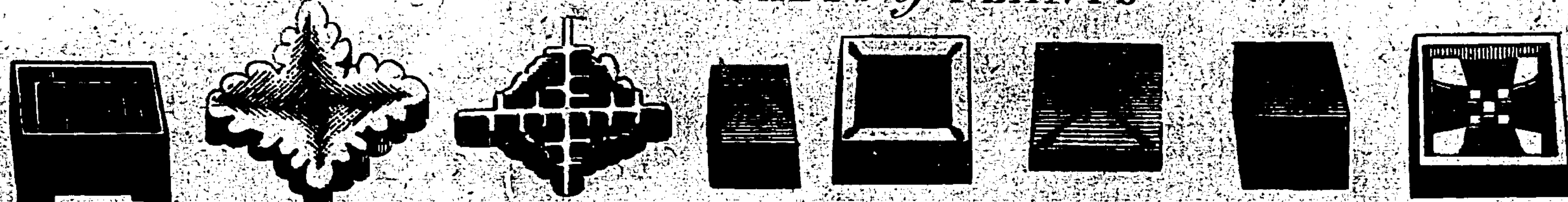
*From Sal Ammoniac*



*Constituent SALTS of Plants*  
*Marine Nitrous Alkaline Acid*



## MARINE SALTS of PLANTS



*Rosemary*

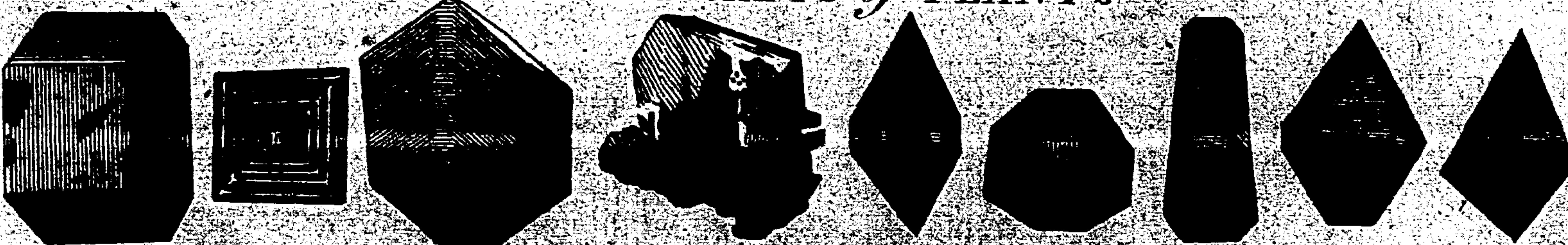
*Garden Scurvygrafs*

*Fern*

*Blackthorn*

*Wormwood*

## Essential SALTS of PLANTS



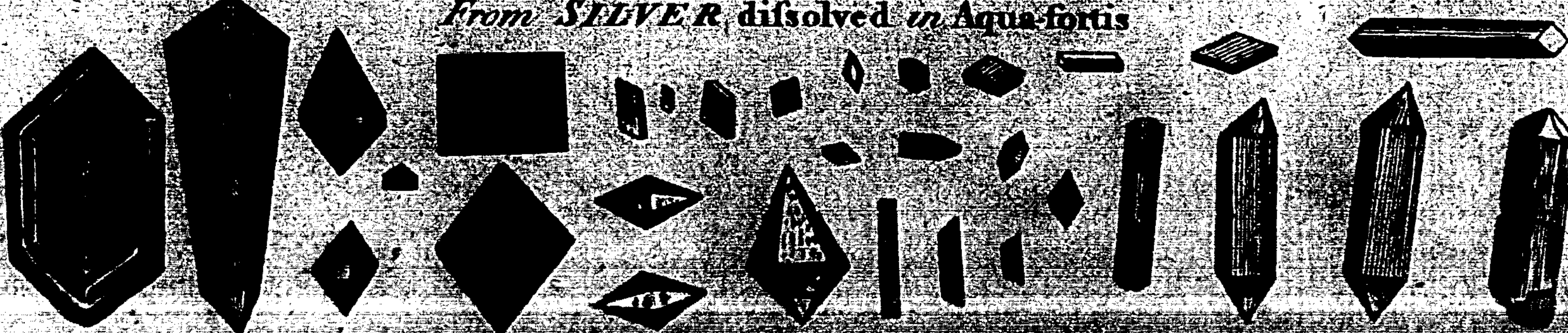
*From Common Sugar*

*Rosemary*

*Wormwood*

*Scurvygrafs*

*From SILVER dissolved in Aqua-fortis*



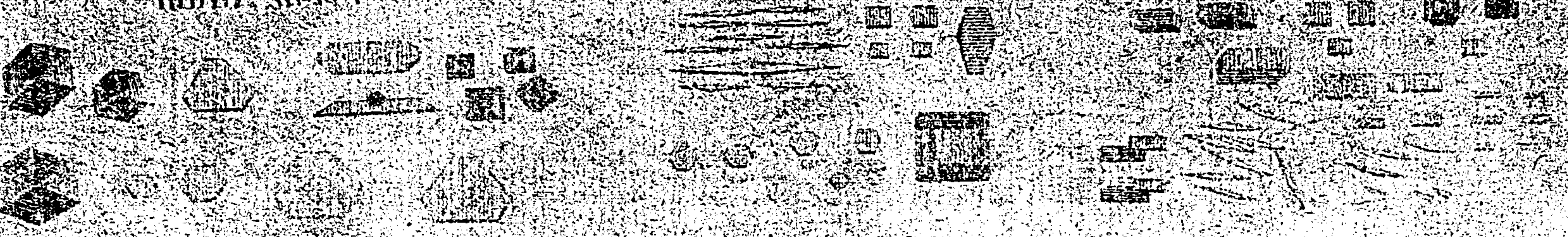


CRYSTALLIZATION

From the Free Salt of  
Carbonate Potash

From Salt of Potash

From Alum



From the Free Salt of  
Carbonate Potash

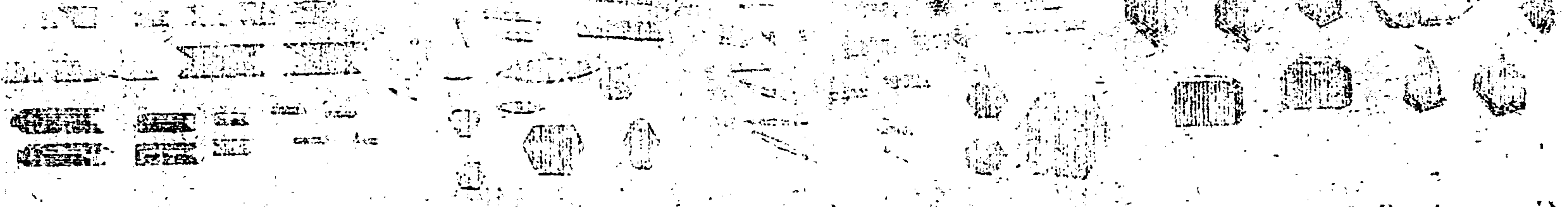
From Alum

From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

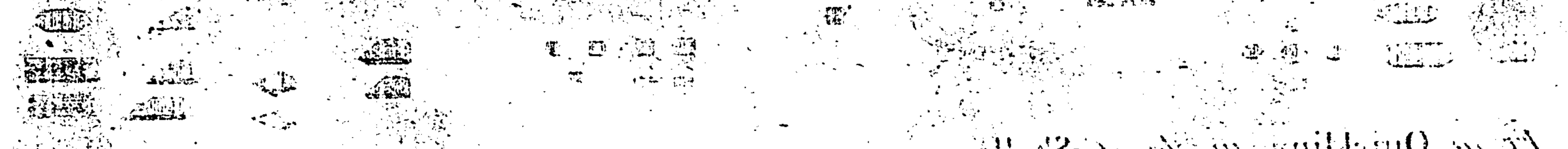


From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

From Alum



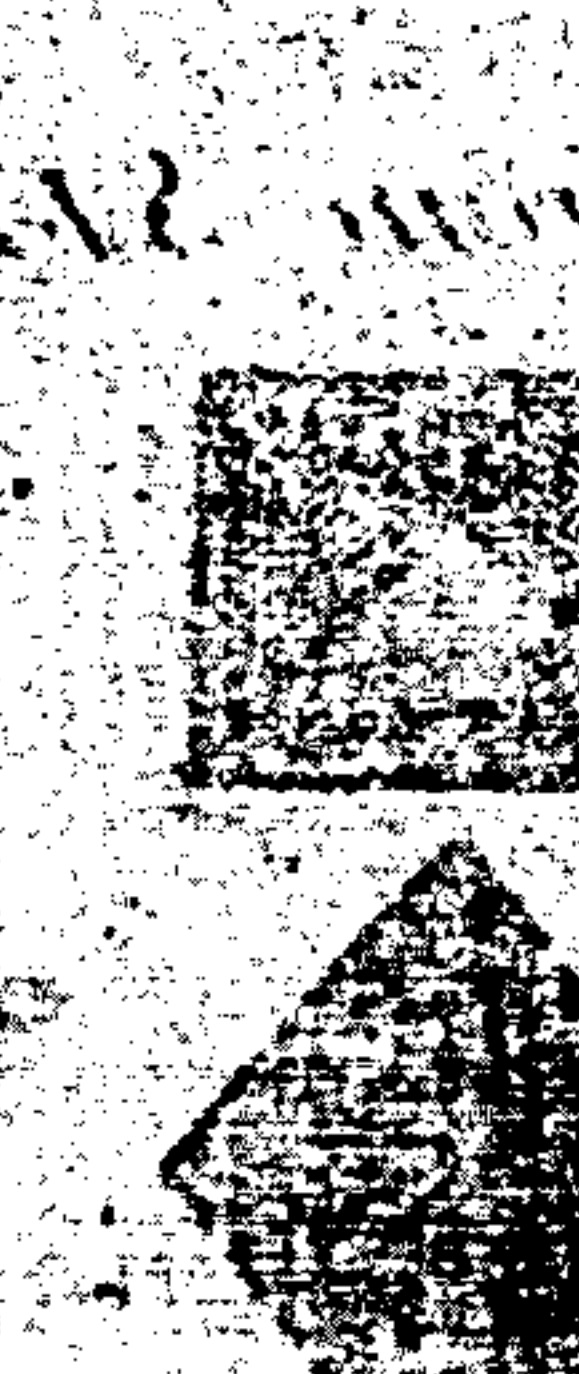
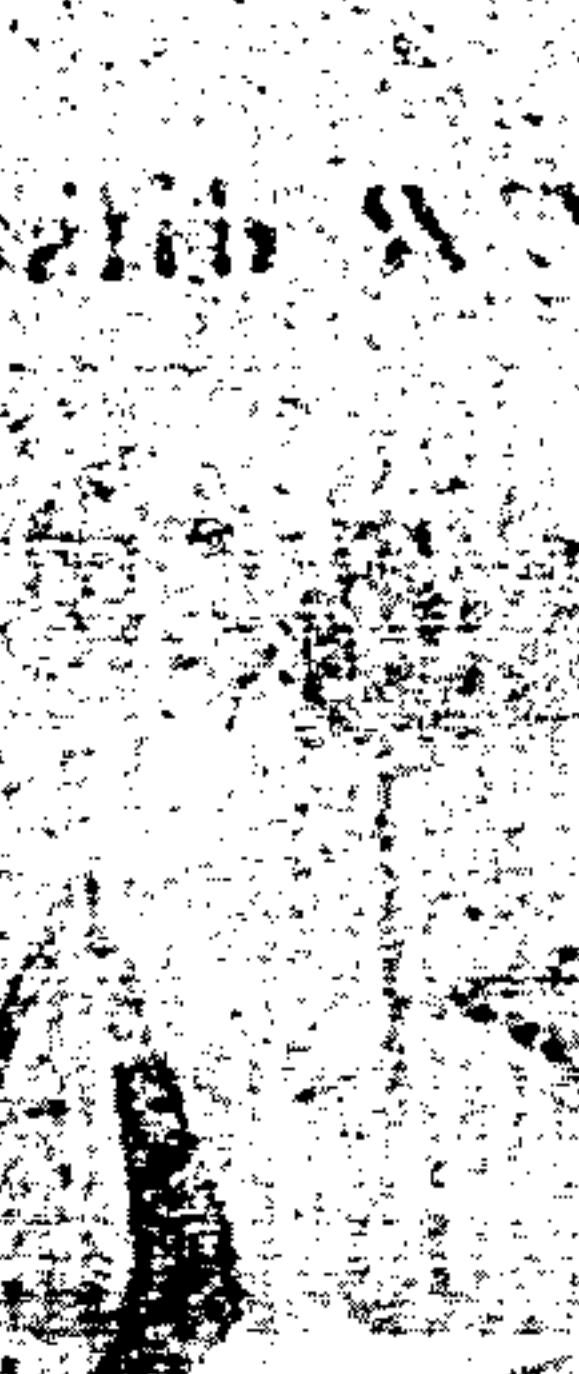
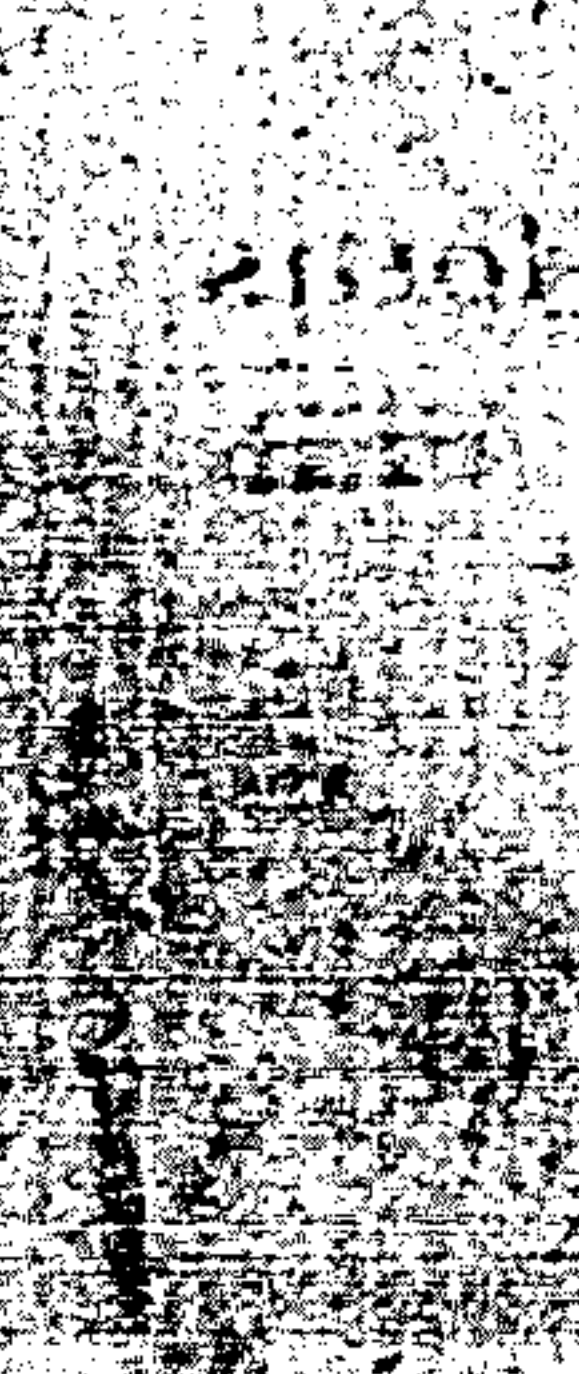
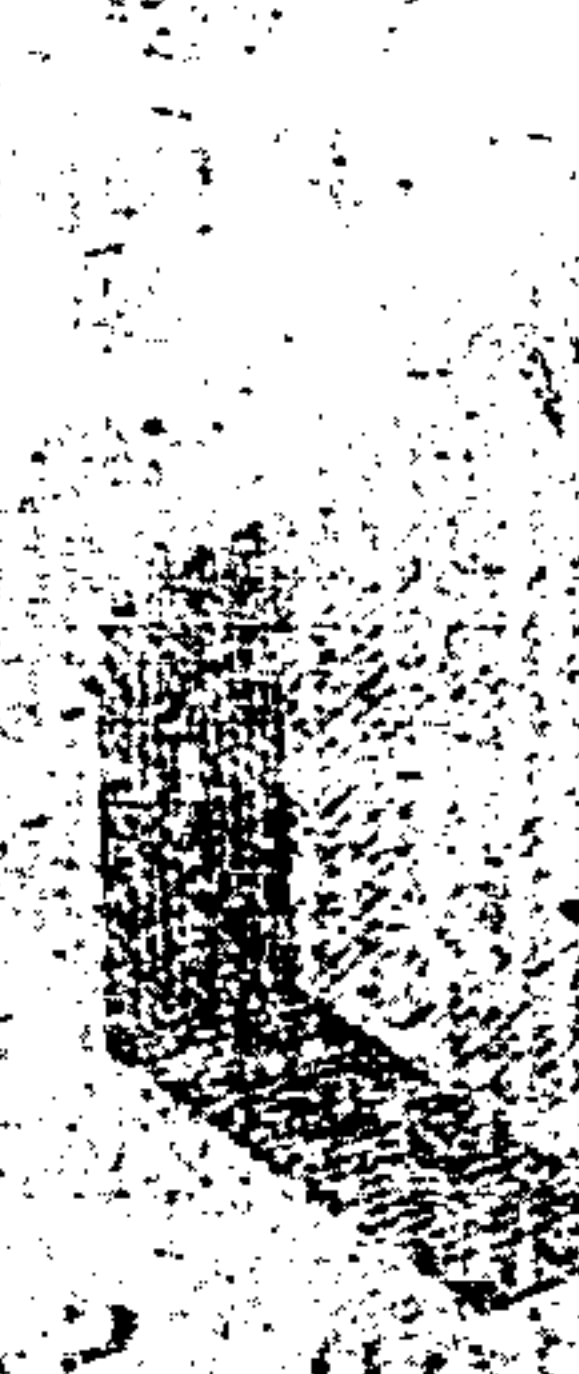
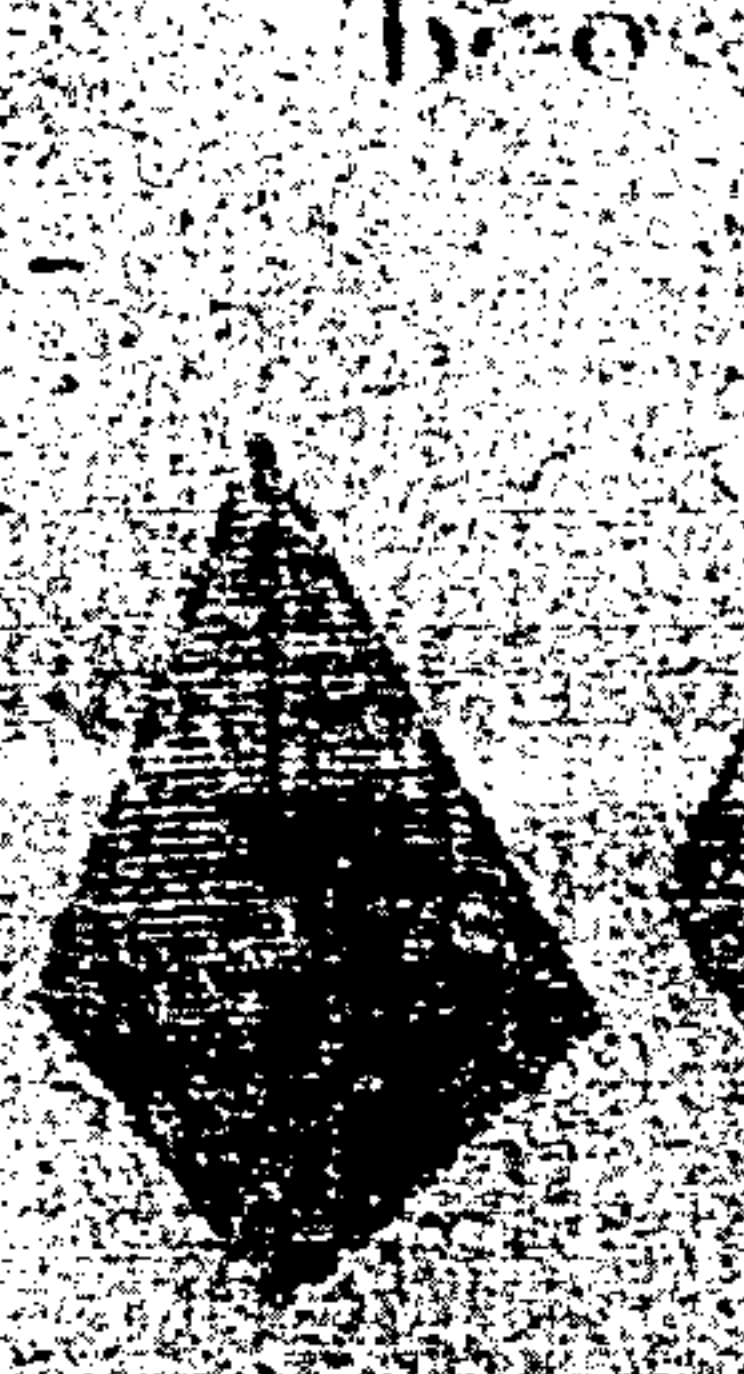
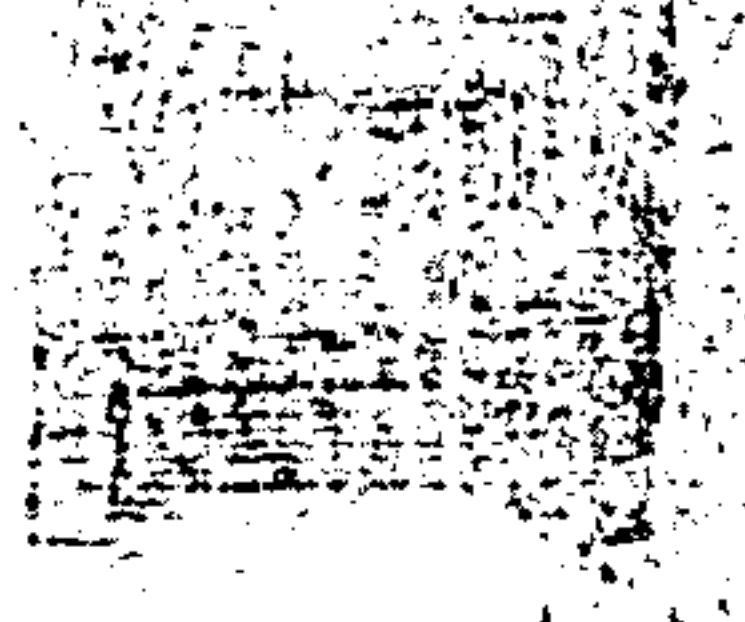
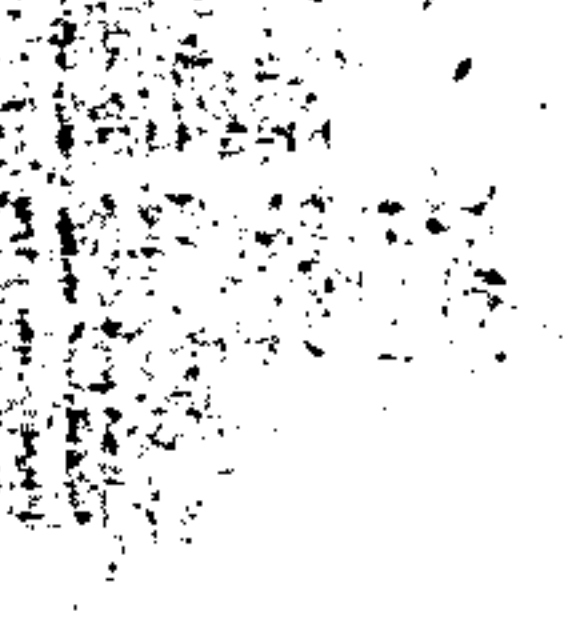
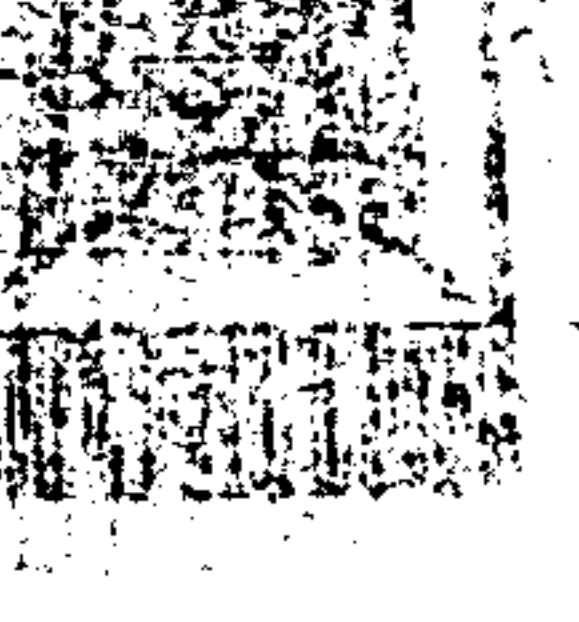
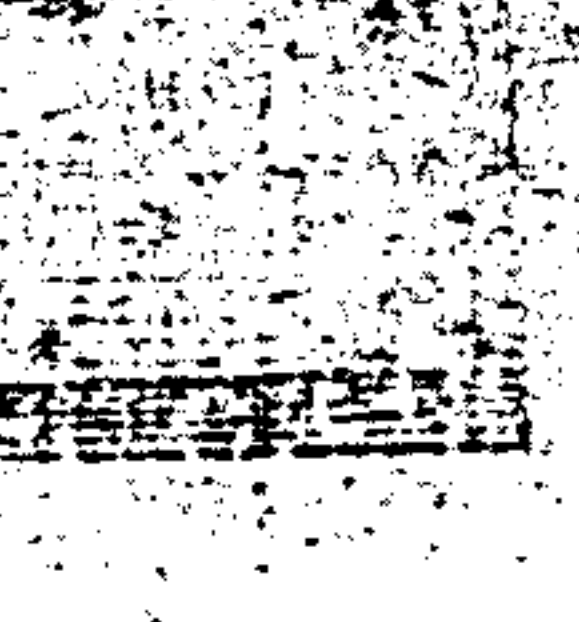
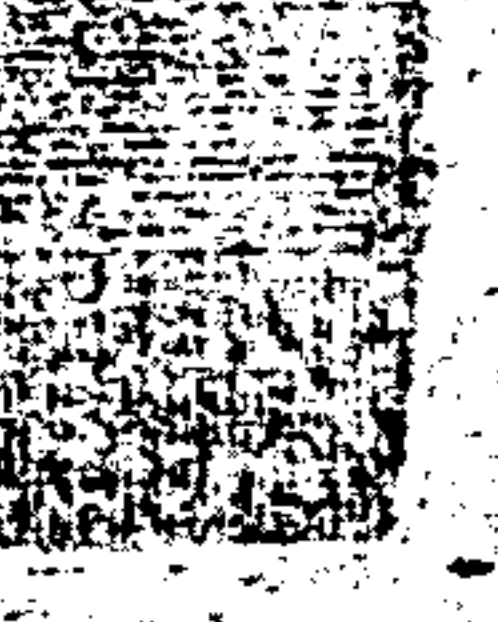
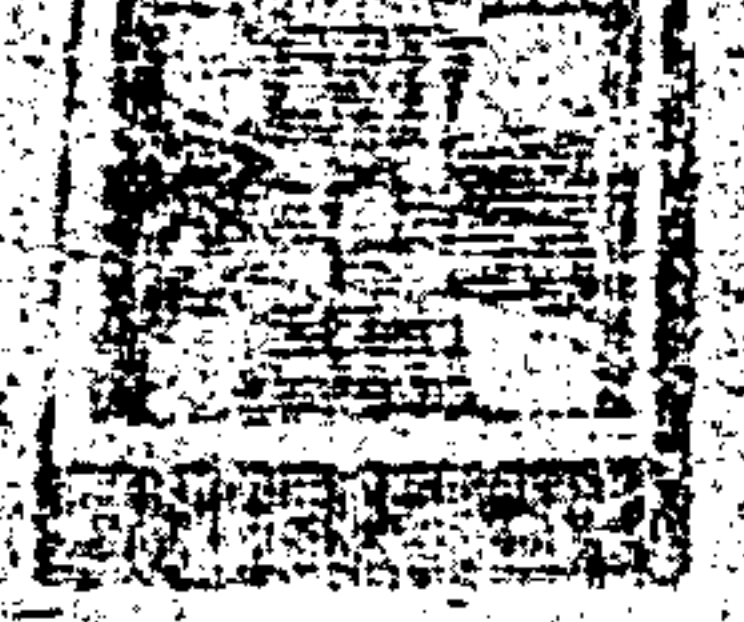
From the Free Salt of  
Carbonate Potash

From the Free Salt of  
Carbonate Potash

From Alum



CRYSTALLIZATION





# BOTANY.

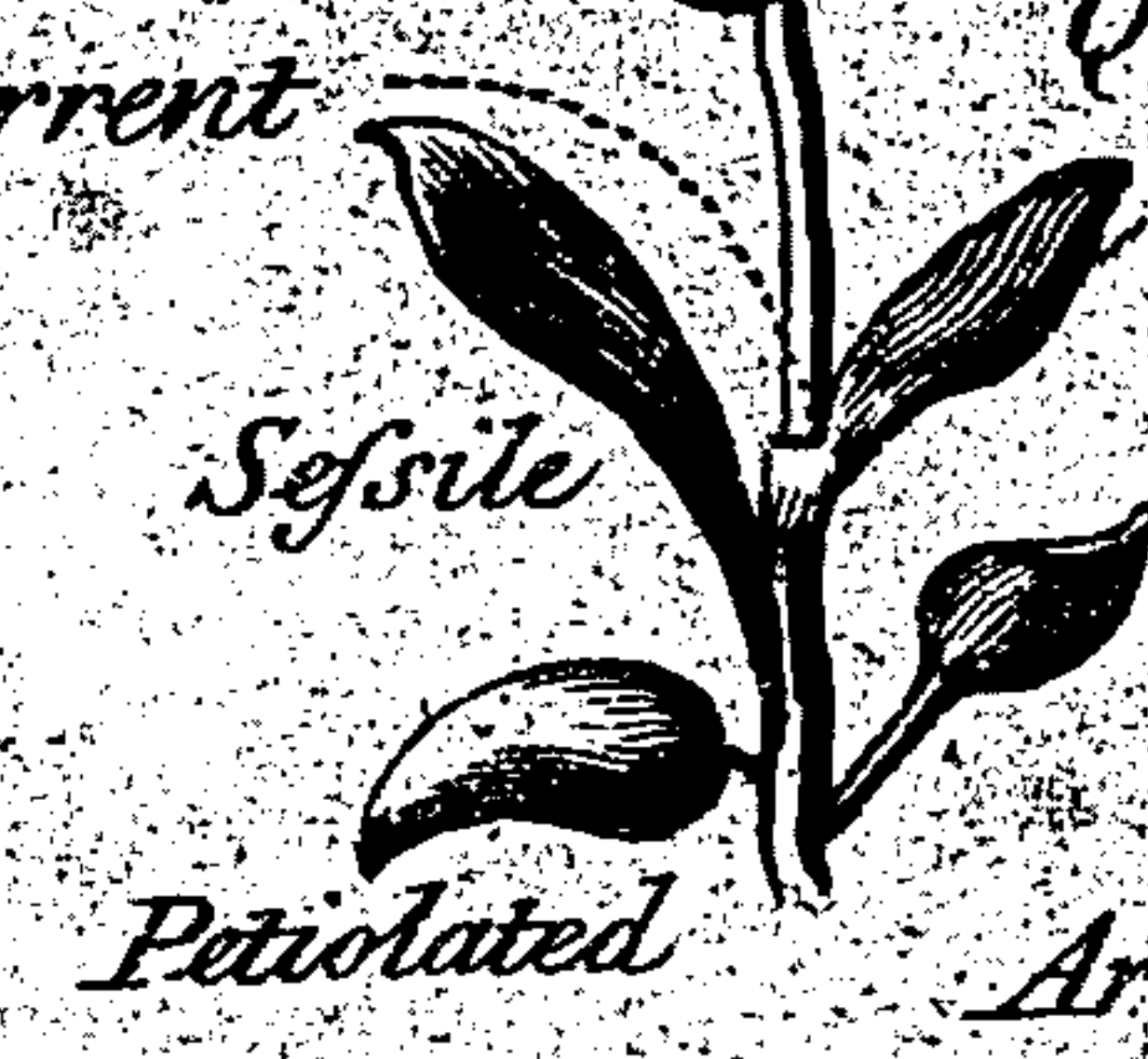
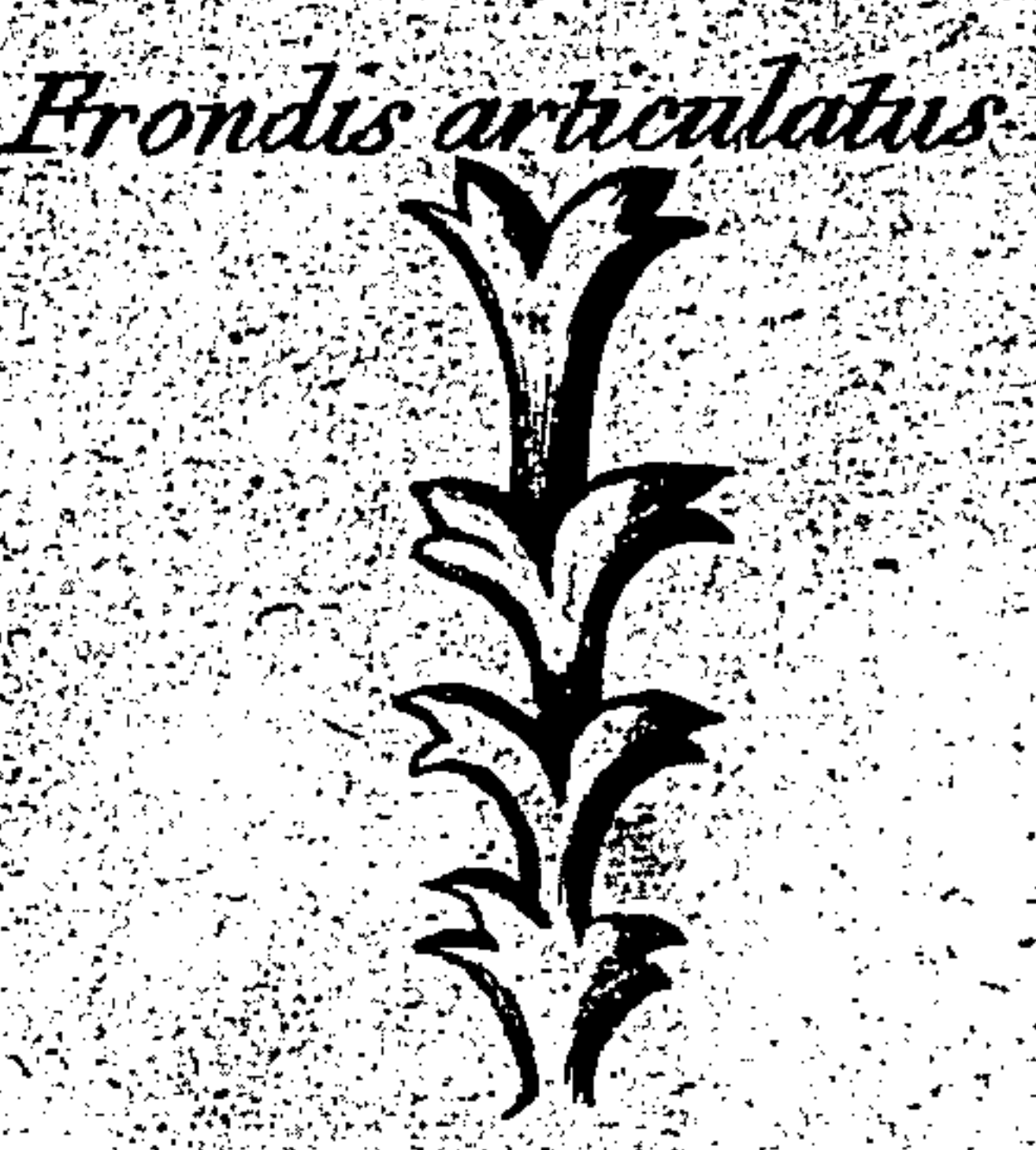
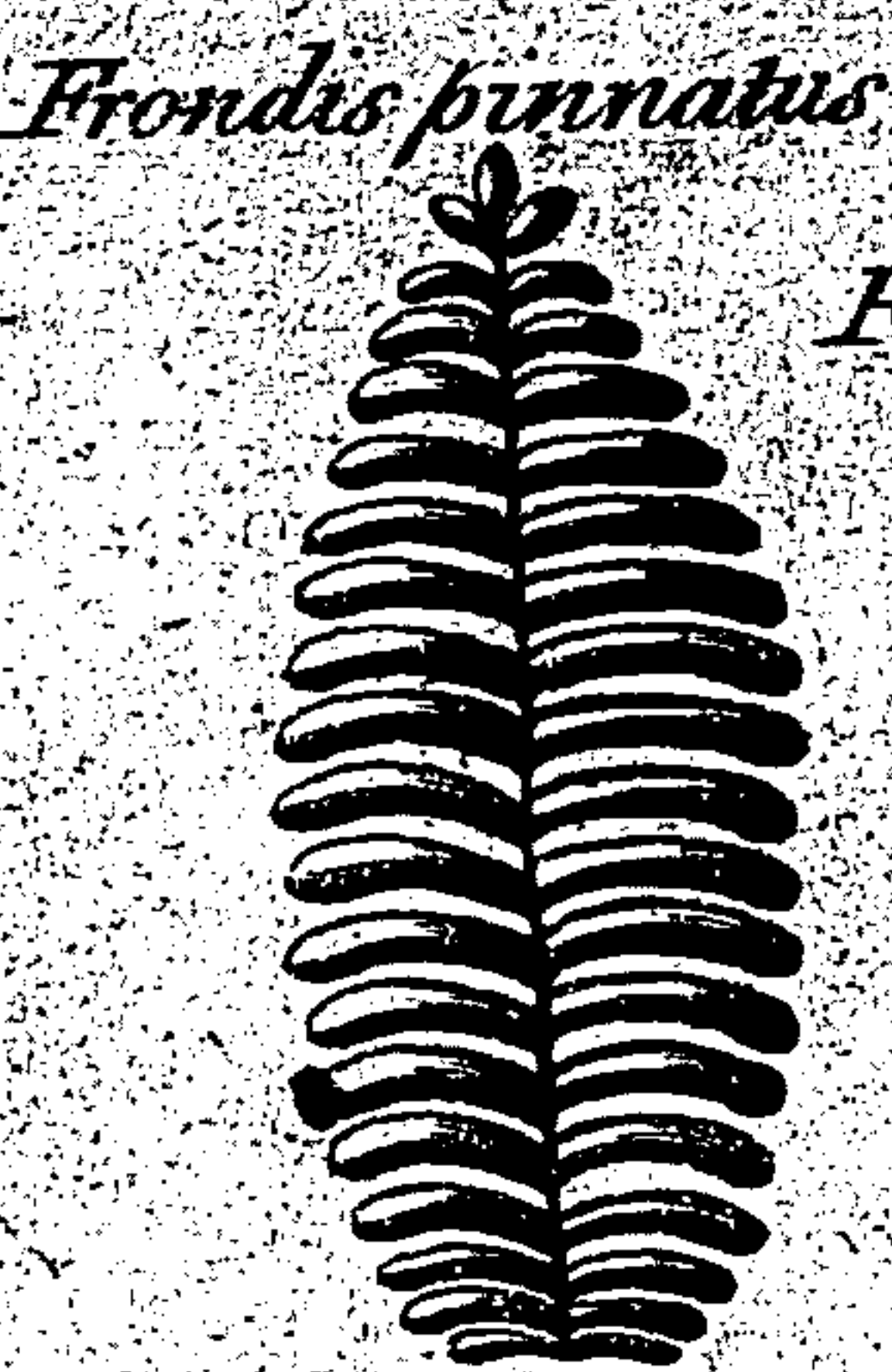
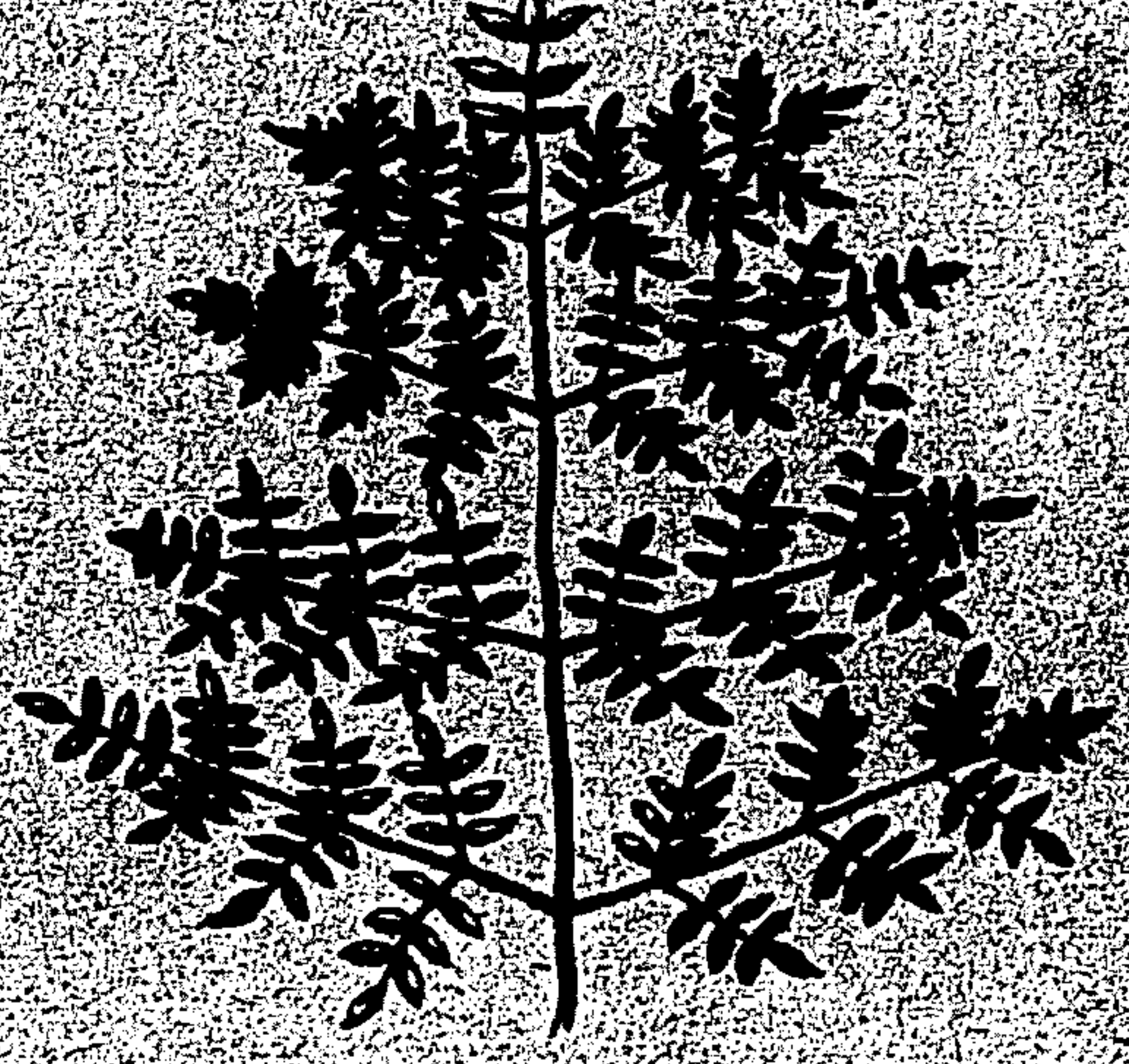
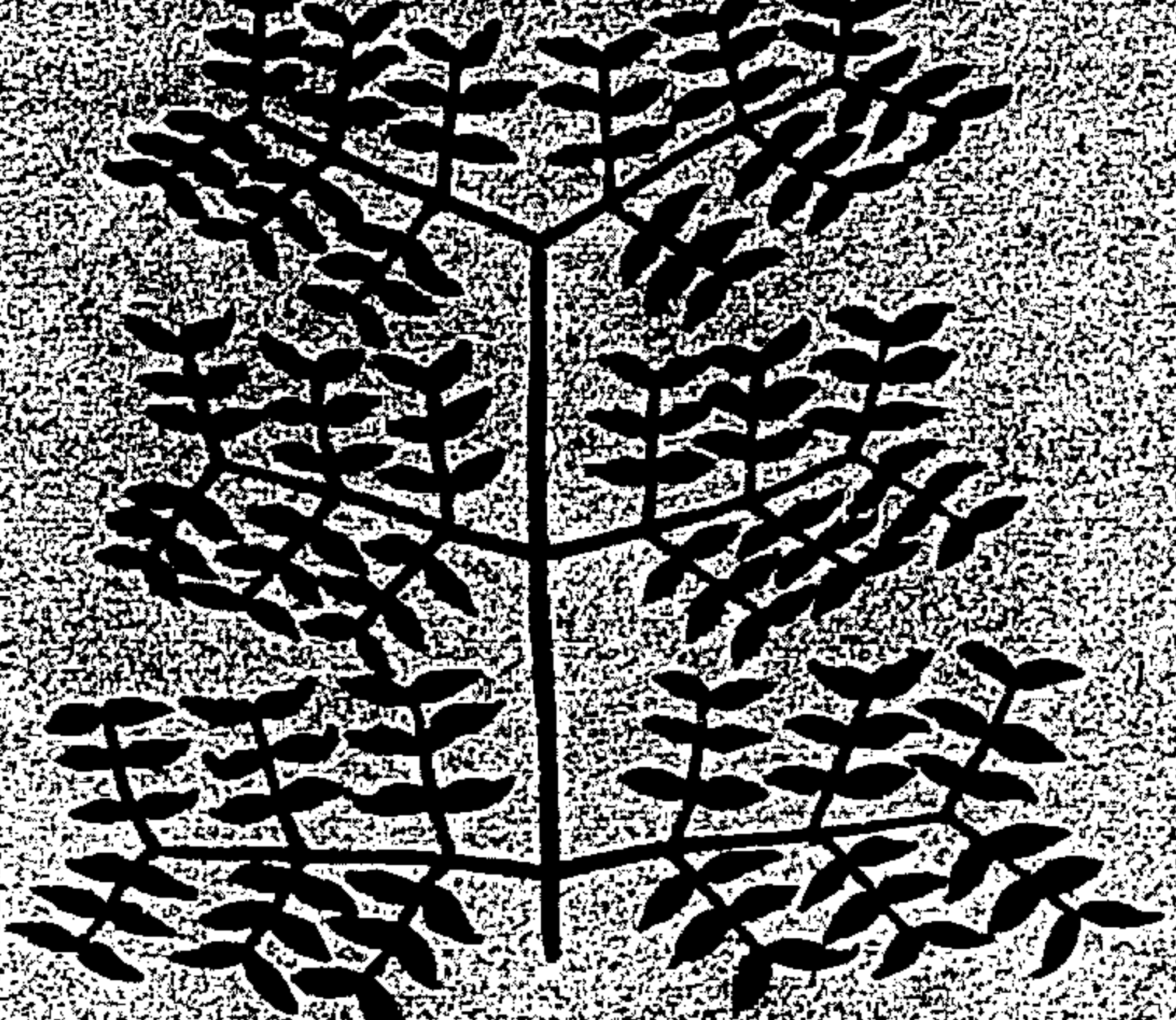
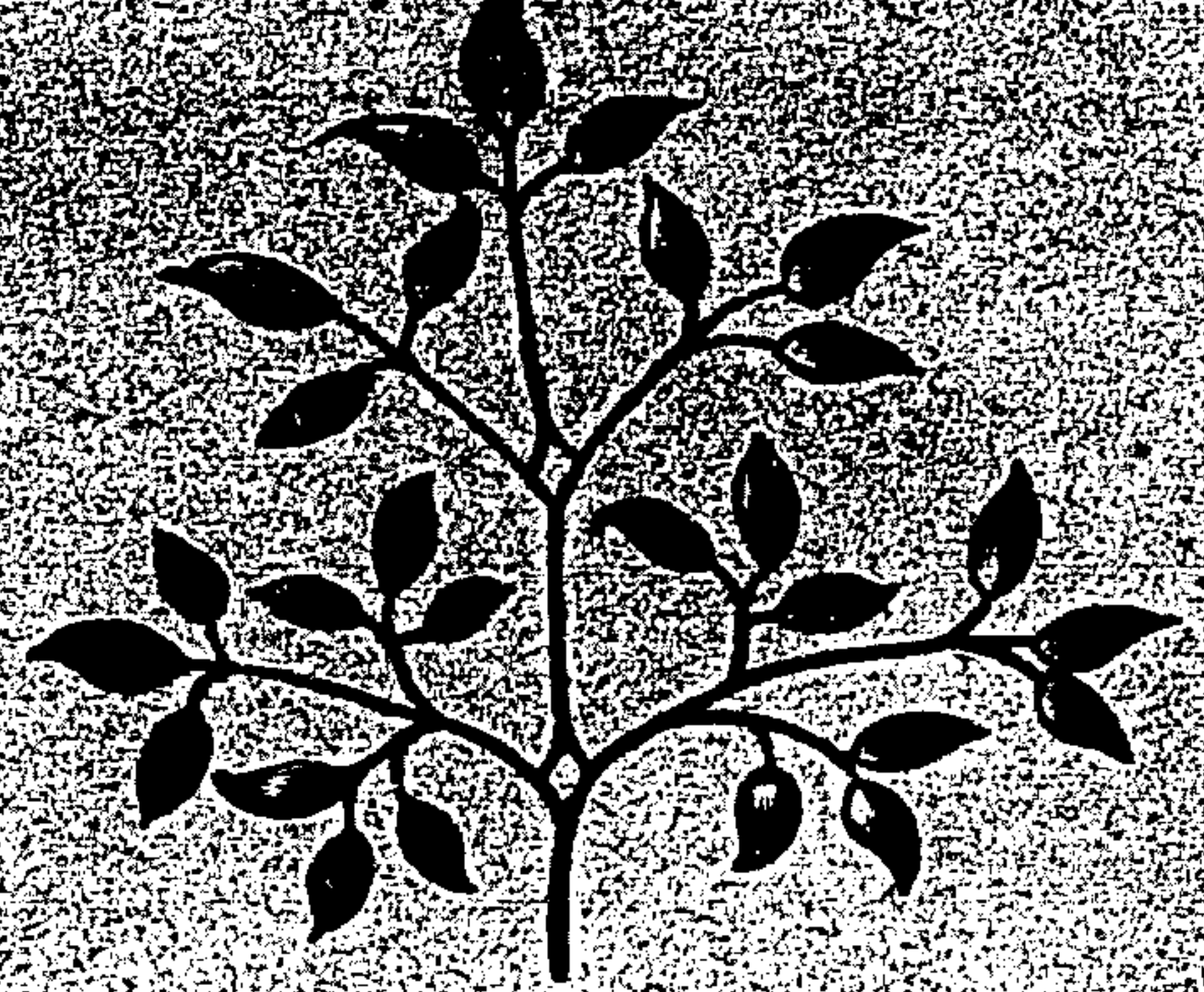
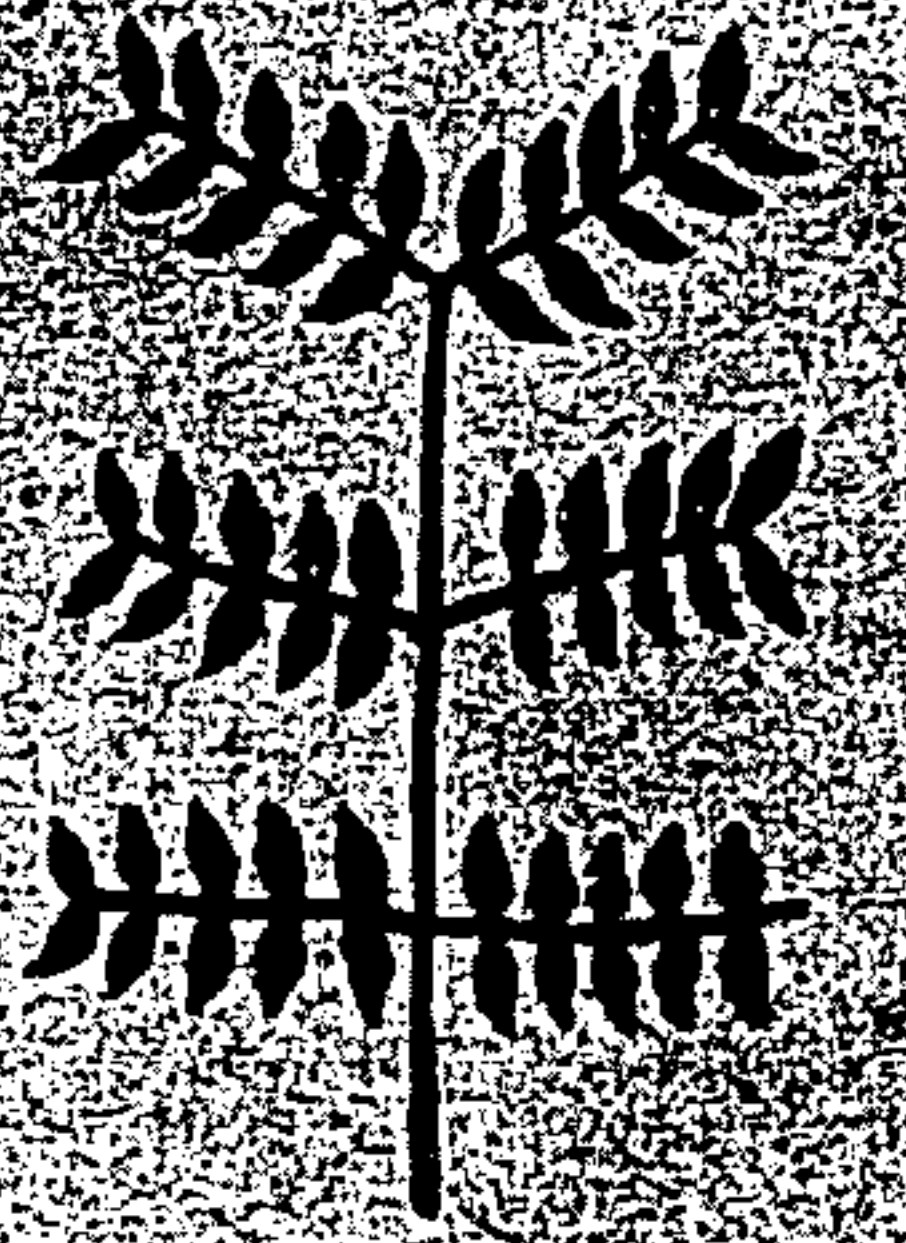
## LEAVES

*Duplicatopinnated*

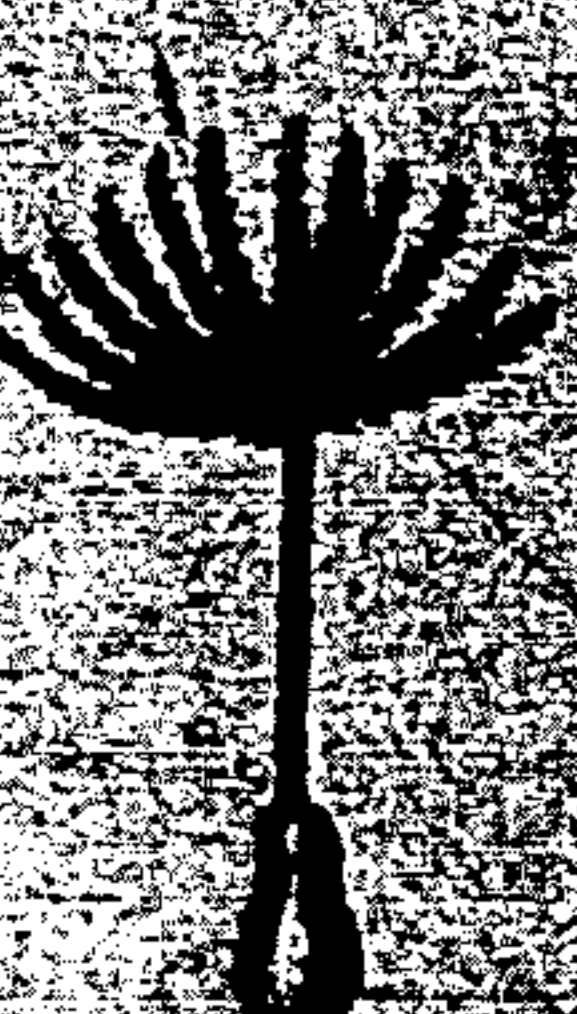
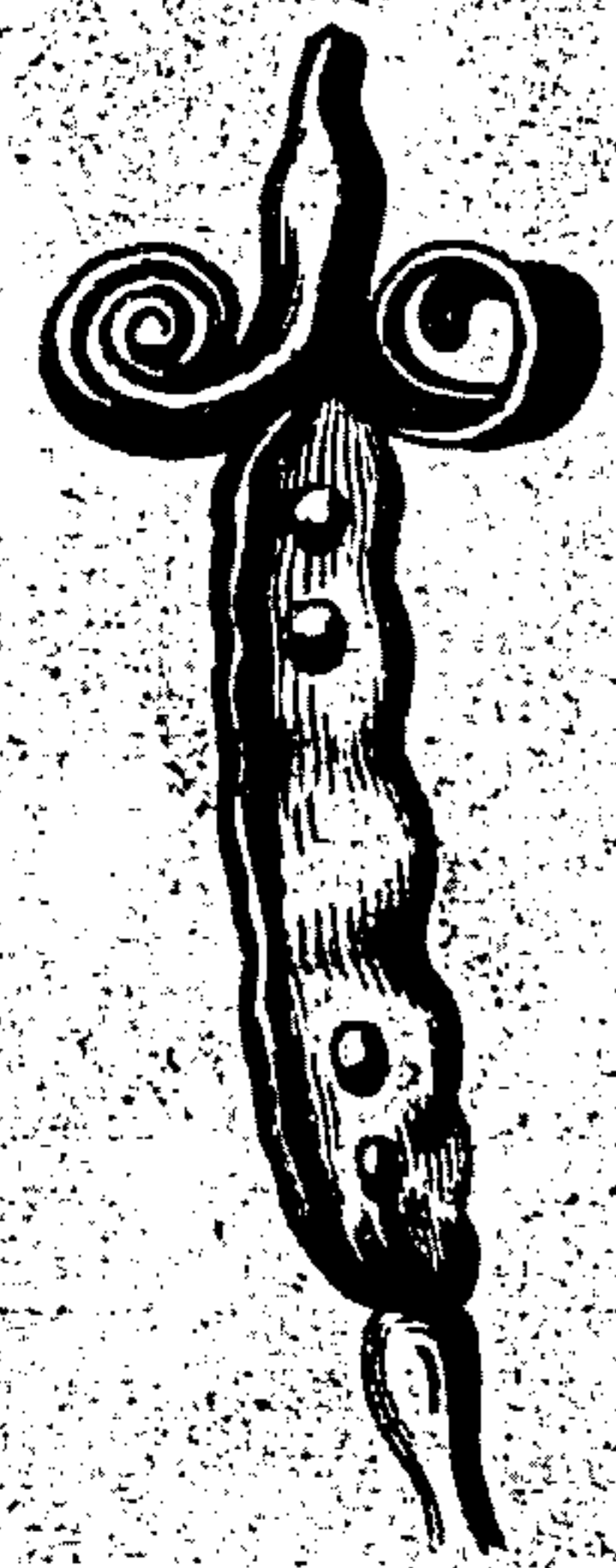
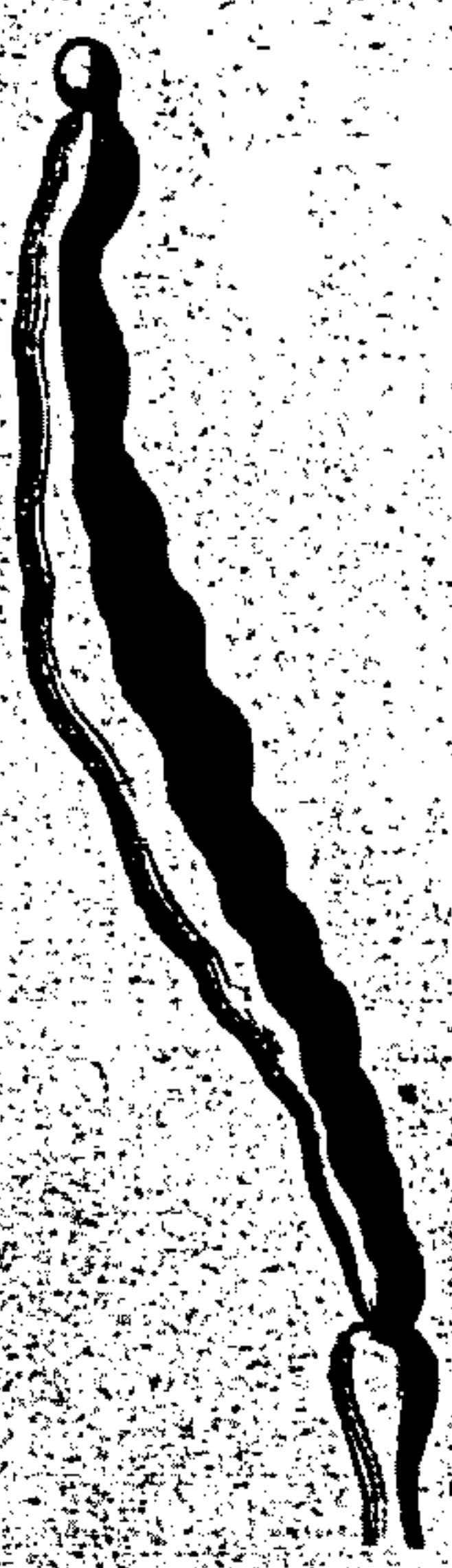
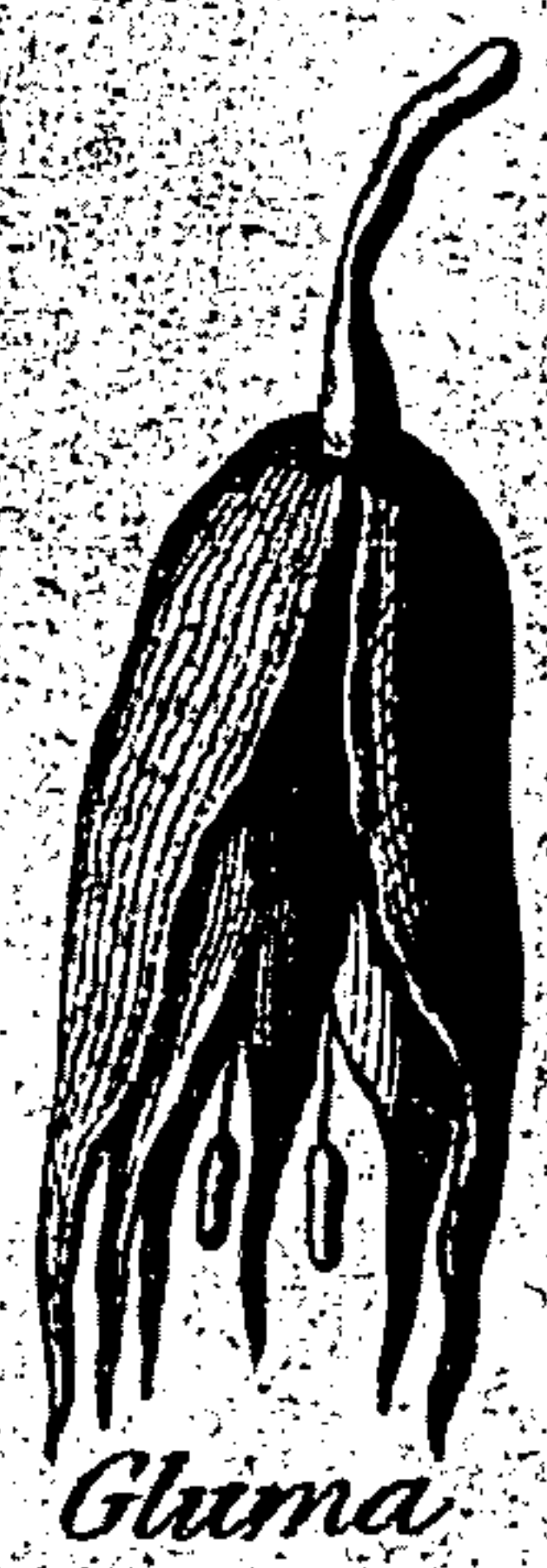
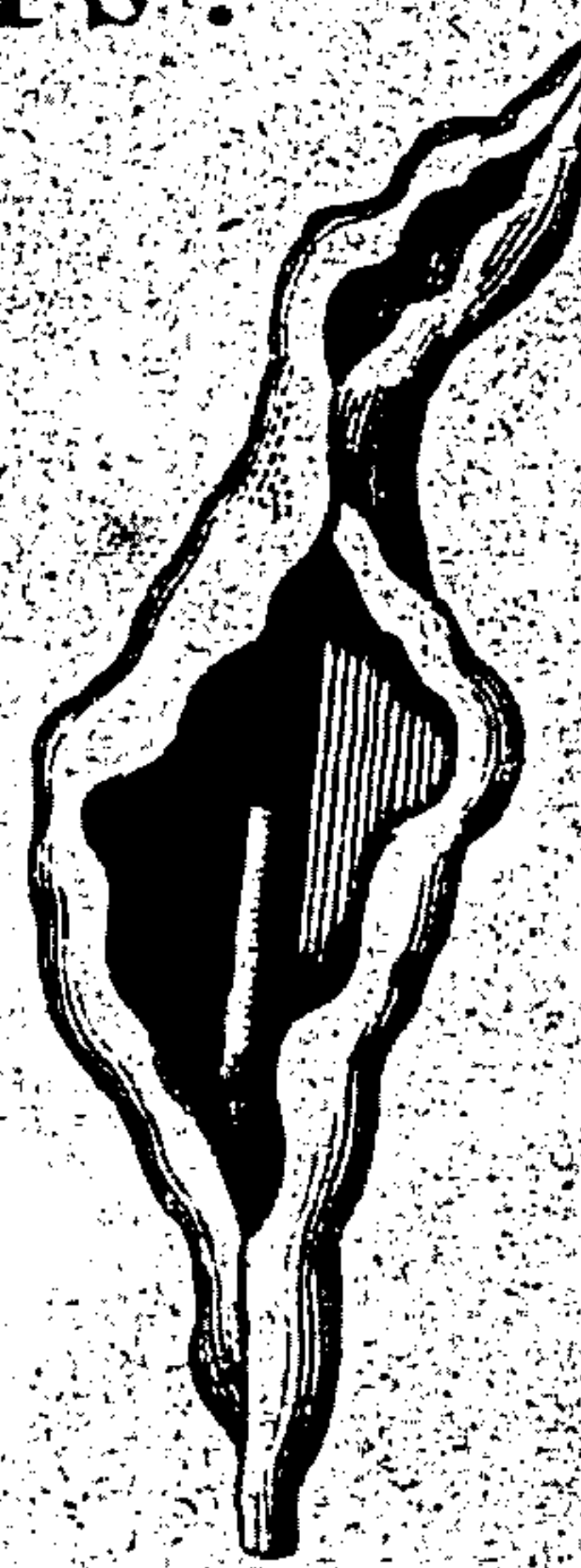
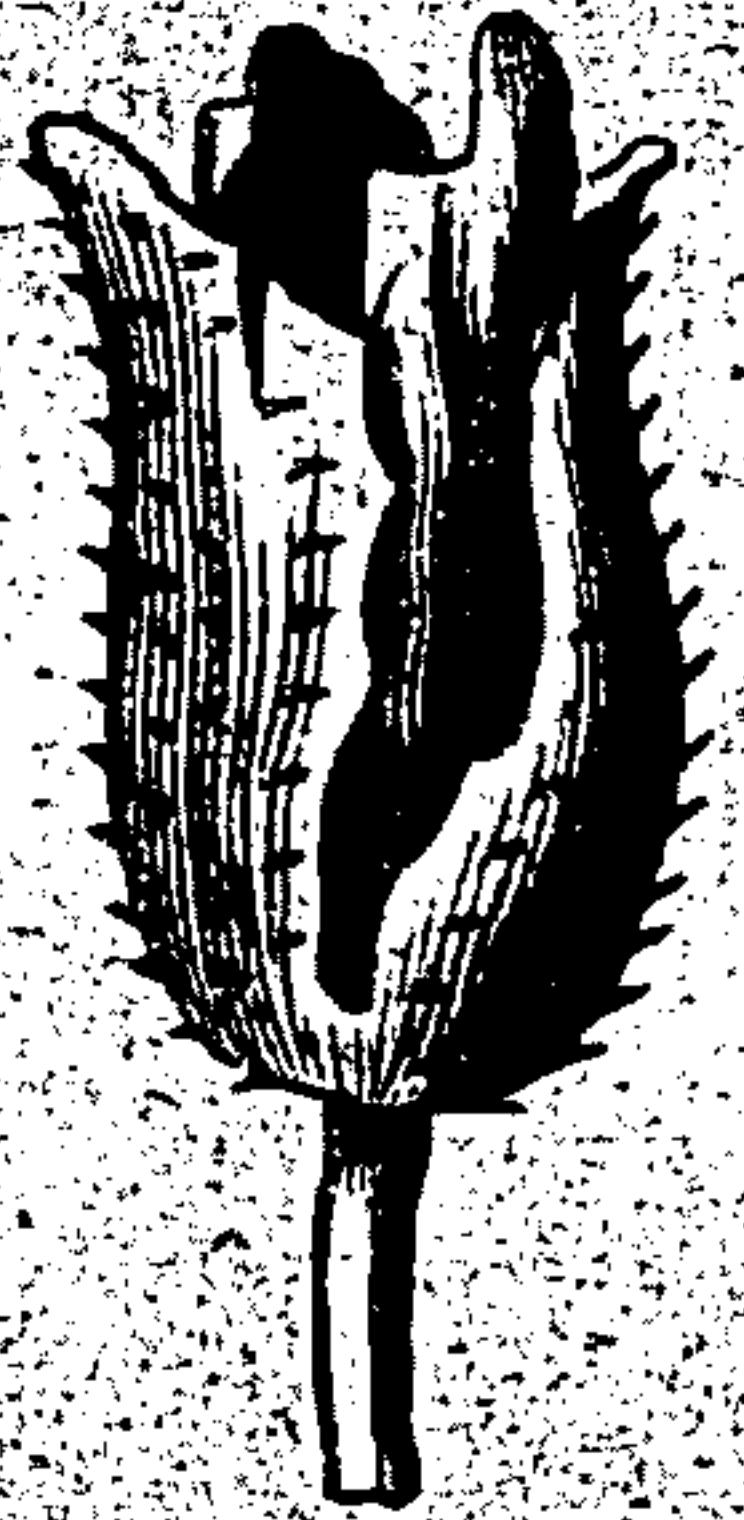
*Triplicato ternate*

*Triplicatopinnated without an odd leaf*

*Triplicatopinnated with an odd leaf*



## PARTS OF CUPS FLOWERS and FRUITS.



Pappus and Coronated Seeds.

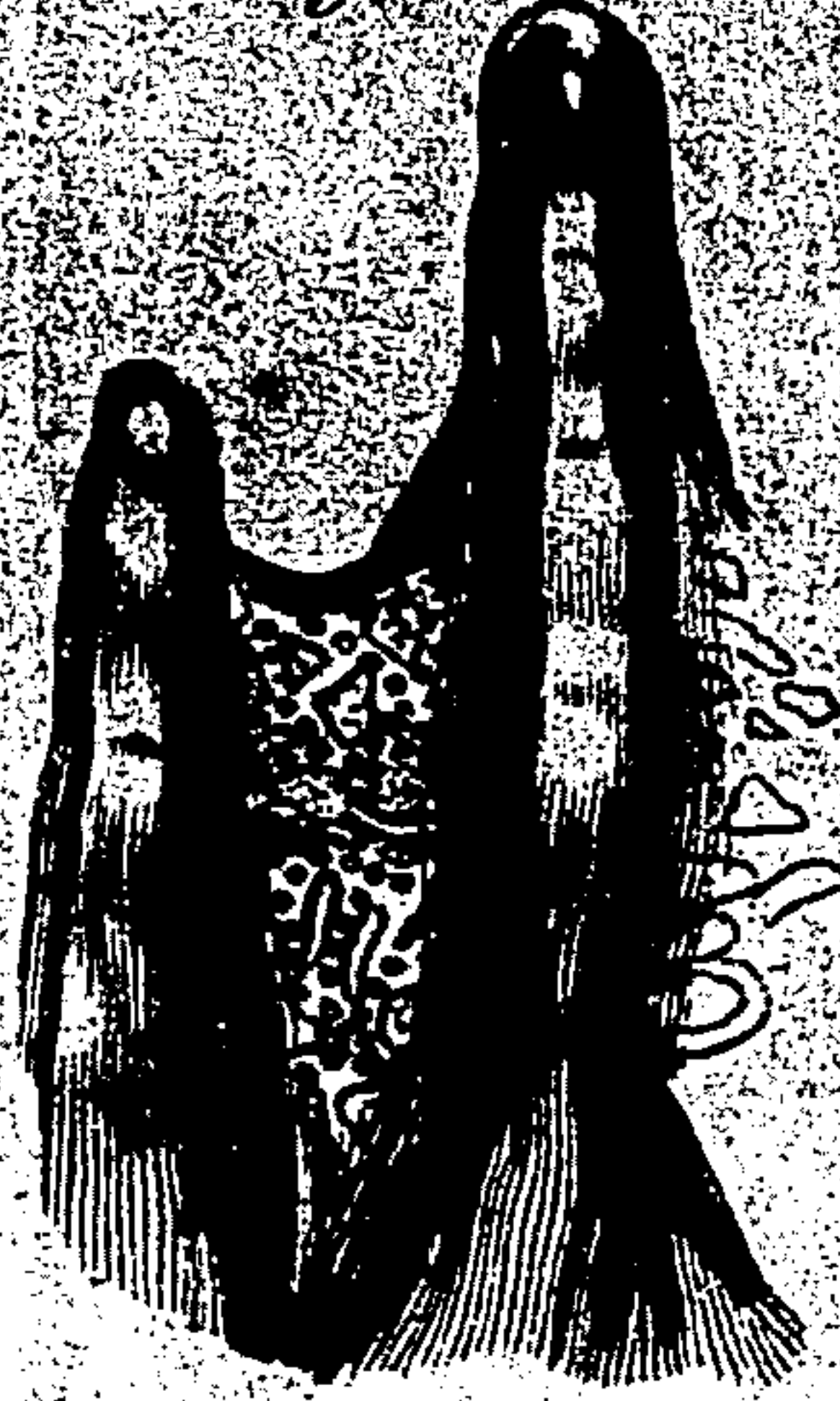


# MICROSCOPICAL OBJECTS

Class I. Animal Subjects

## Circulation of the BLOOD

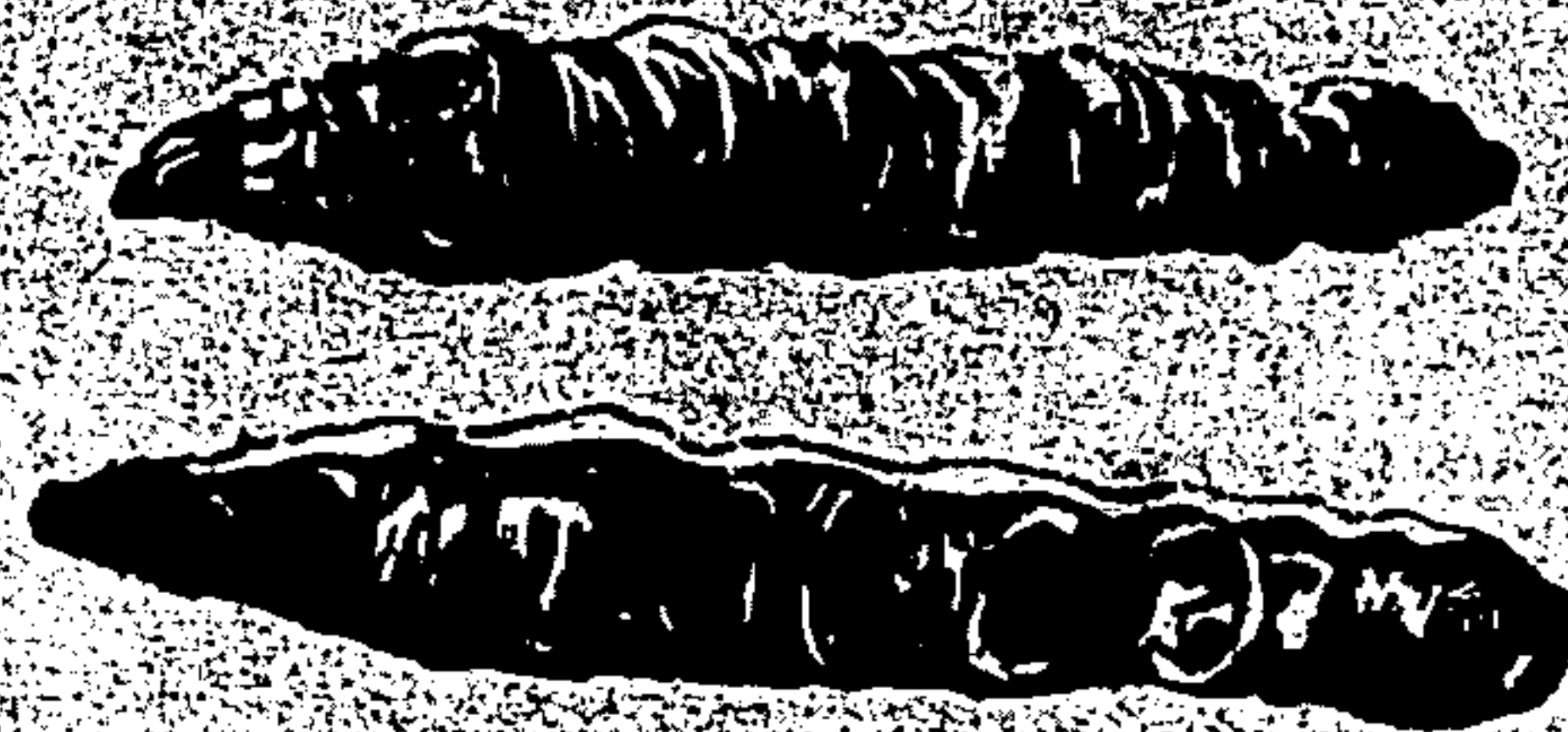
In the Membrane  
of a Frog's Foot



In the Tail of a  
small Fish



## CONNAUGHT WORM



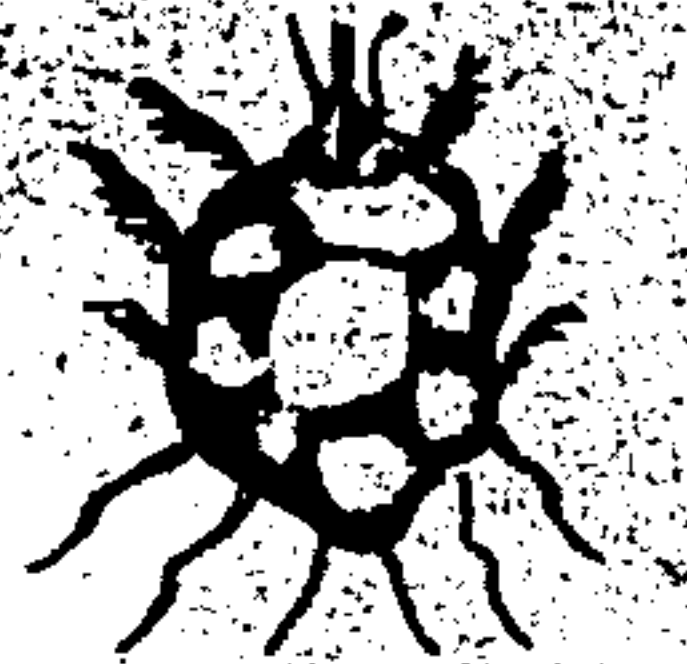
## FLEA



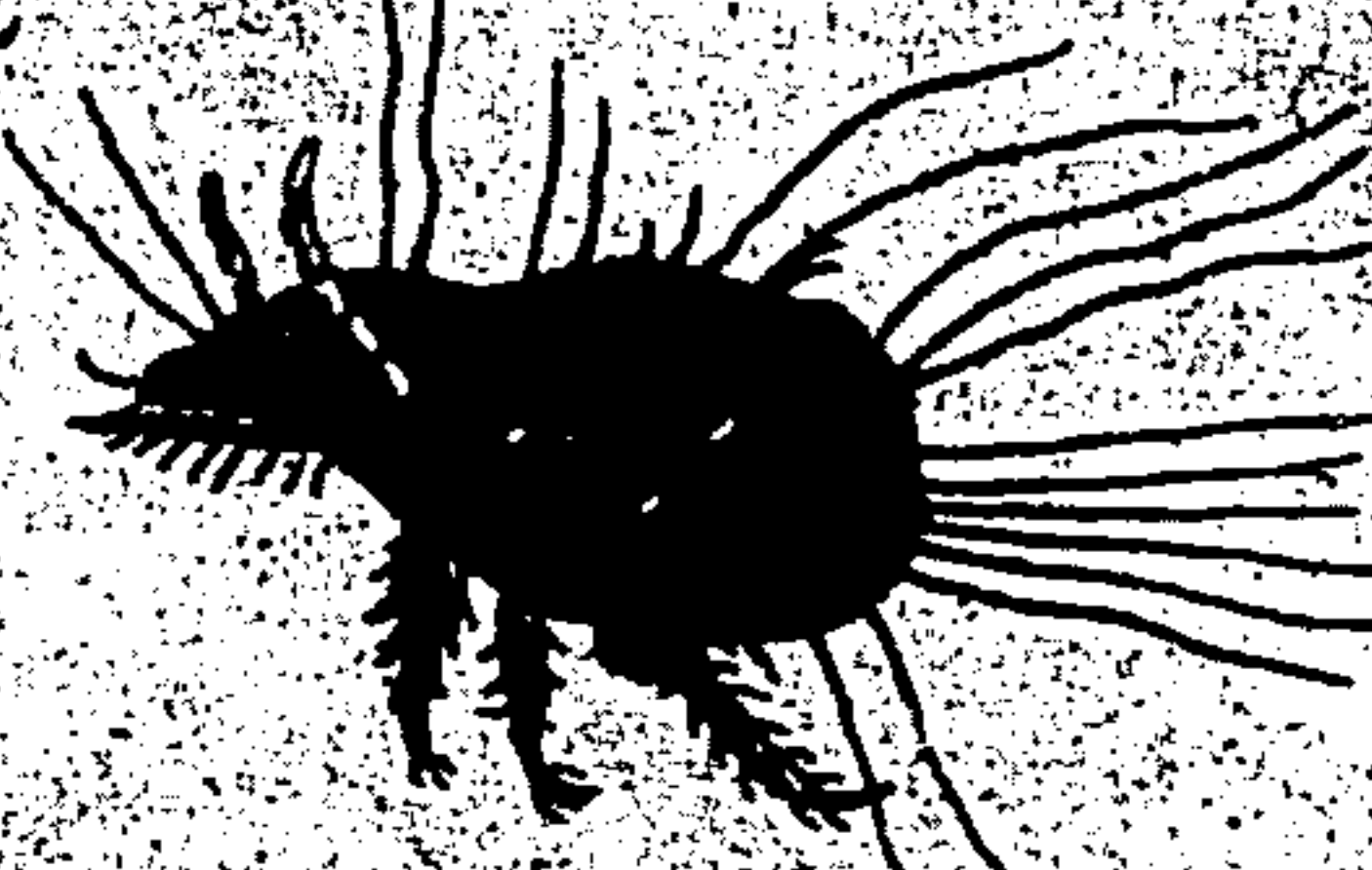
## LOUSE



## ITCH ANIMAL



## MITE



## FLYING CICINDELA



## SEA SCOLOPENDRA



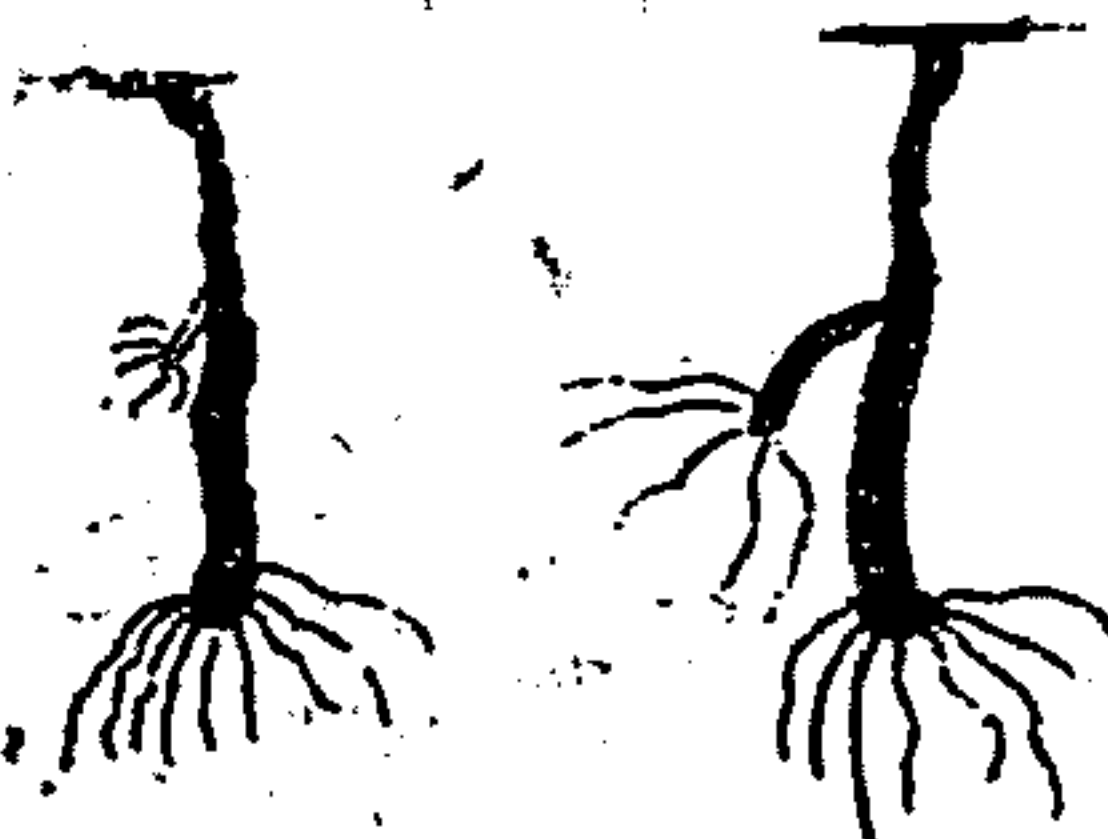
Bristle of a Mite



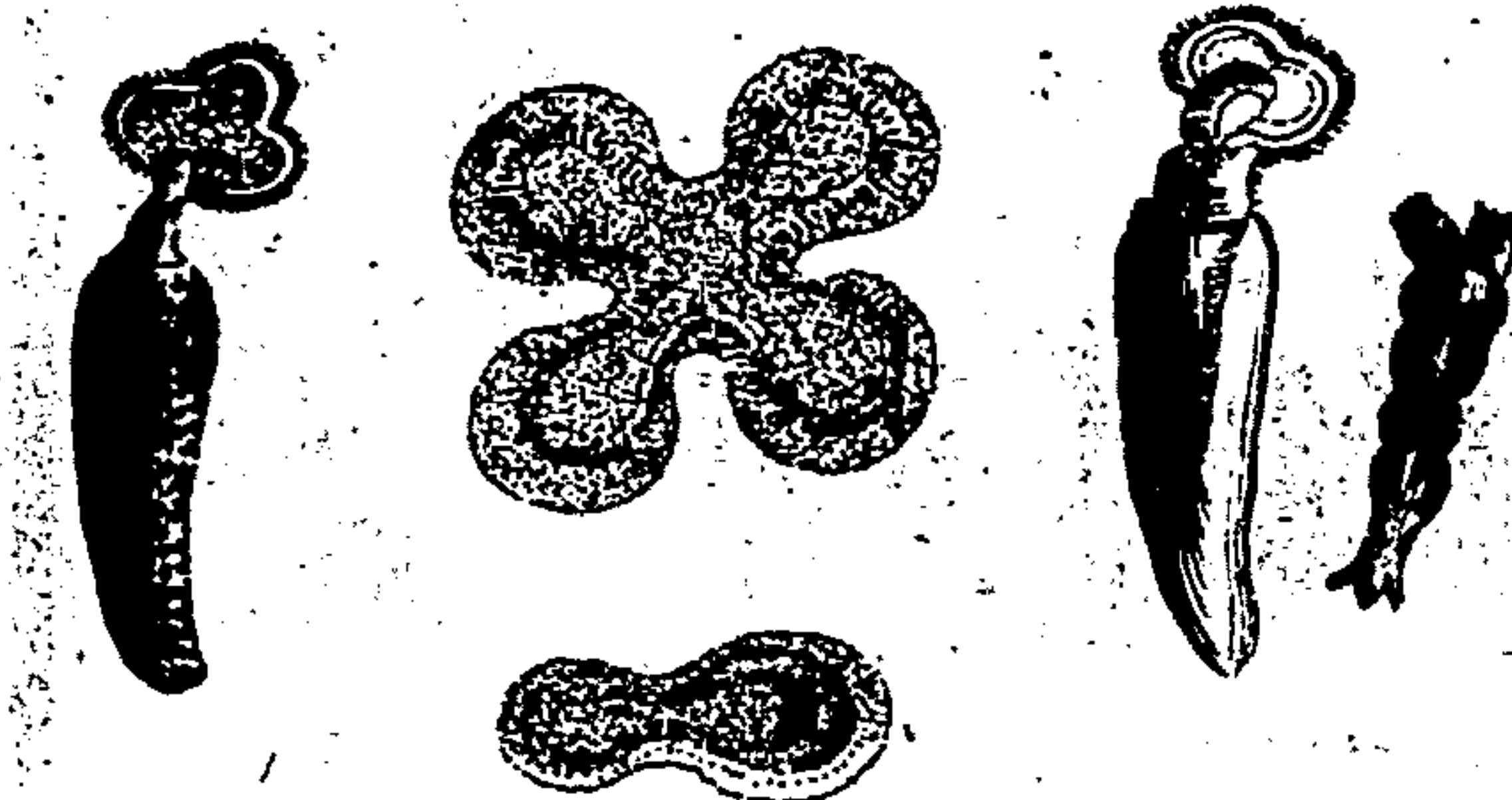
## BELL POLYPE



## P O - L Y P E -



## Wheel Animals



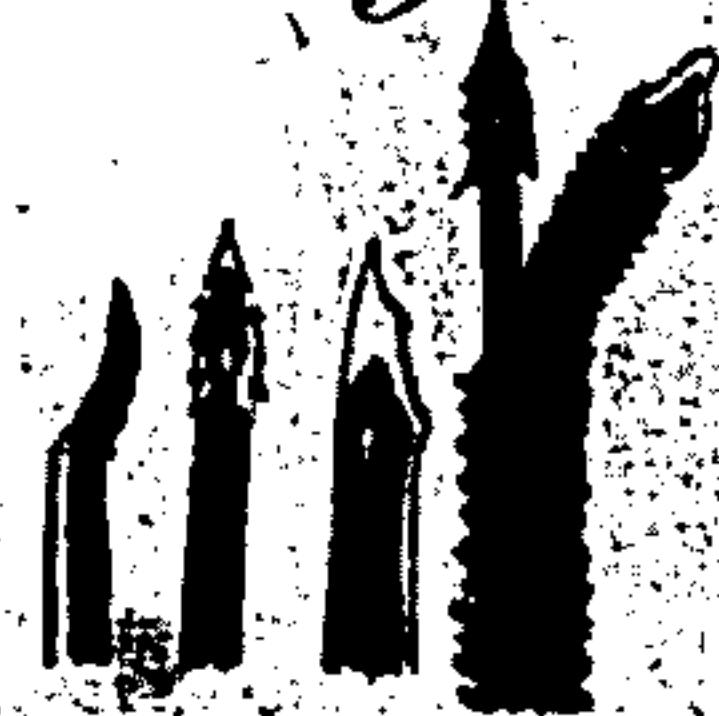
## Crufted Water Animalcules



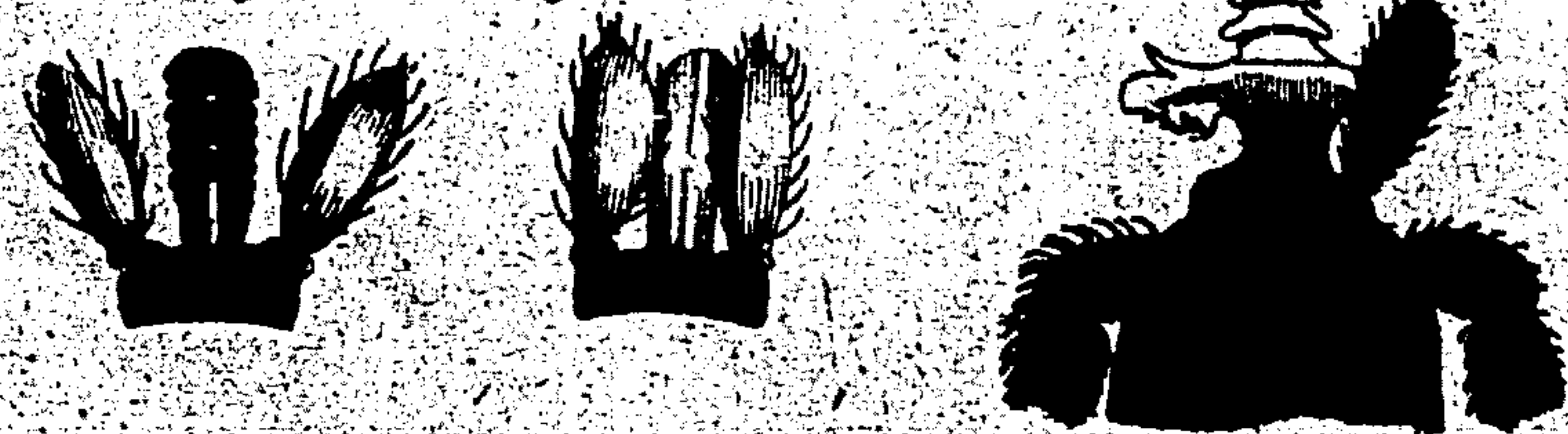
Tail of D?



Darts of the Gnat



P R O B O S C I S  
of the Dog Tick of the little Black Tick

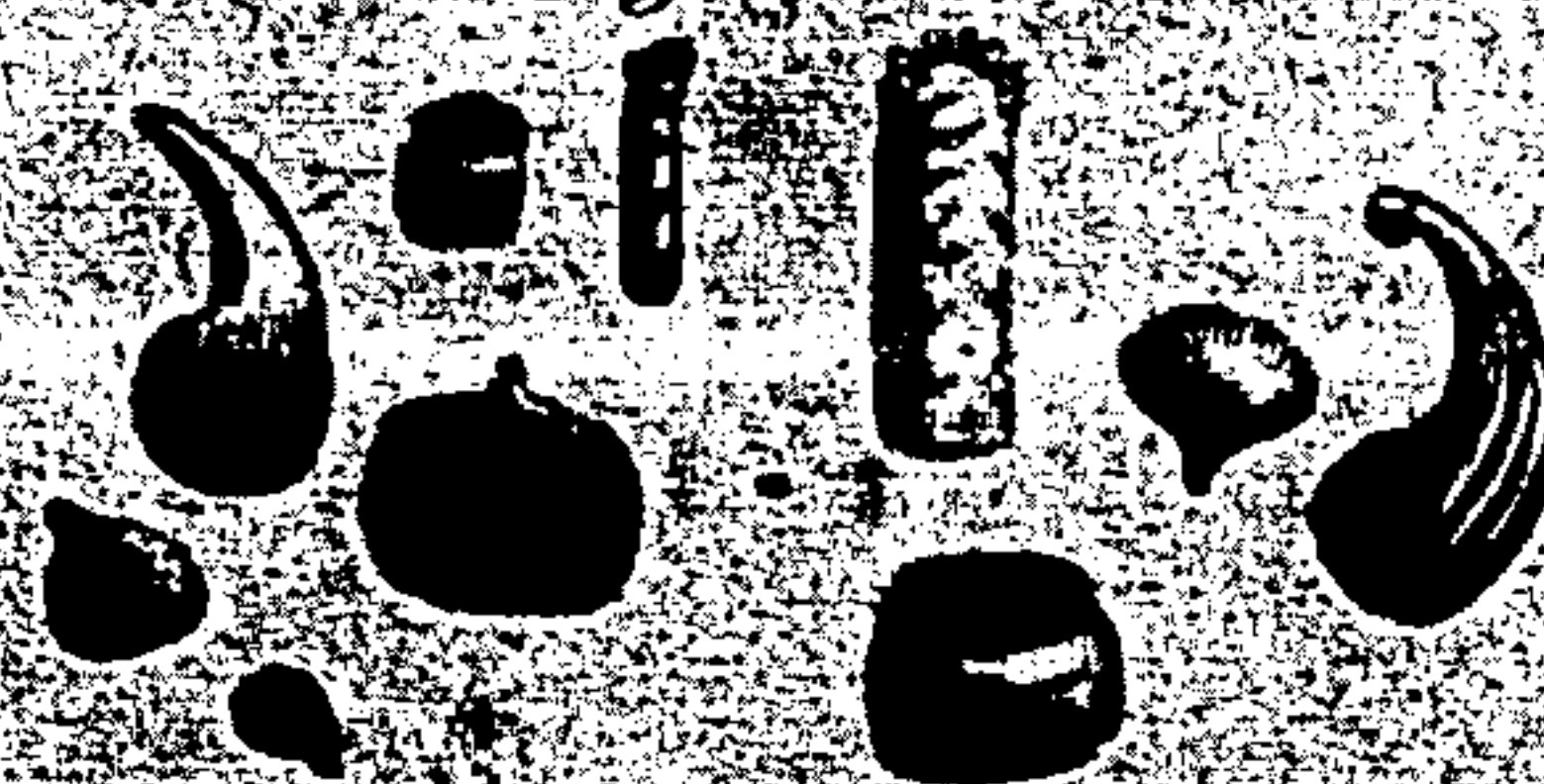


## A N I M A L C U L E S

In Pepper Water



In Hay Water



In Dunghill Water



In Male Seed



Men

Rams

Frogs

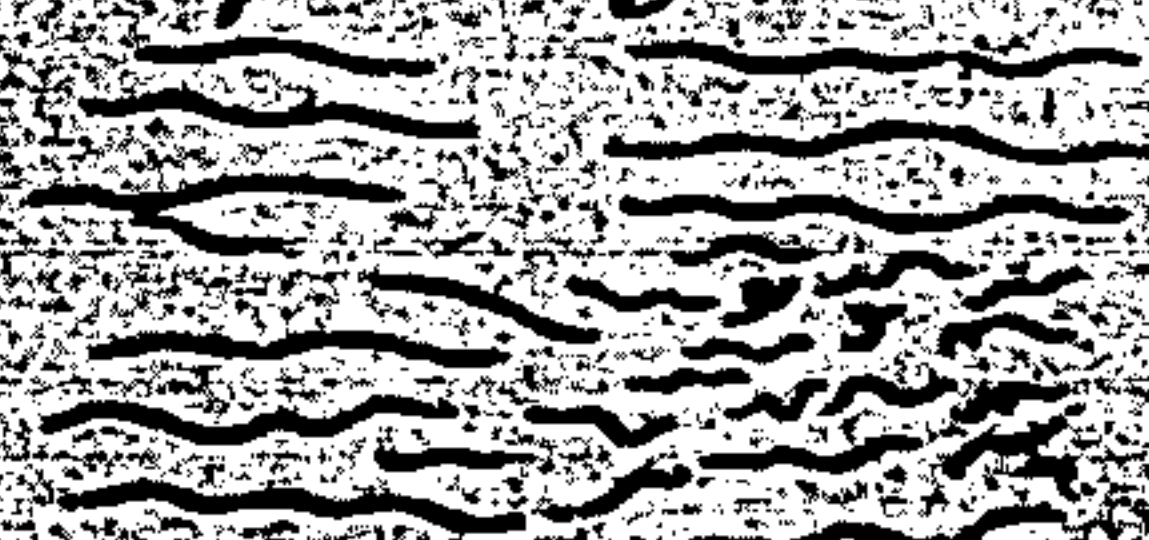
Dogs

Rabbits

Stags

Cocks

Capillary Eels





# BOTANY.

## Tournefort's System Genera of Plants.

### CLASS XIV. Plants with Radiated Flowers.



### CLASS XV. Plants with Apetalous or Stameneous Flowers.



### CLASS XVI. Plants which have Seeds but seem to have no Flowers.



### CLASS XVII. Plants which seem to have neither Flowers nor Seeds.



### CLASS XVIII. Trees and Shrubs with Apetalous Flowers.



### CLASS XIX. Trees and Shrubs with Amentaceous Flowers.



### CLASS XX. Trees and Shrubs with Monopetalous Flowers.



### CLASS XXI. Trees and Shrubs with Rosaceous Flowers.



### CLASS XXII. Trees and Shrubs with Papilionaceous Flowers.

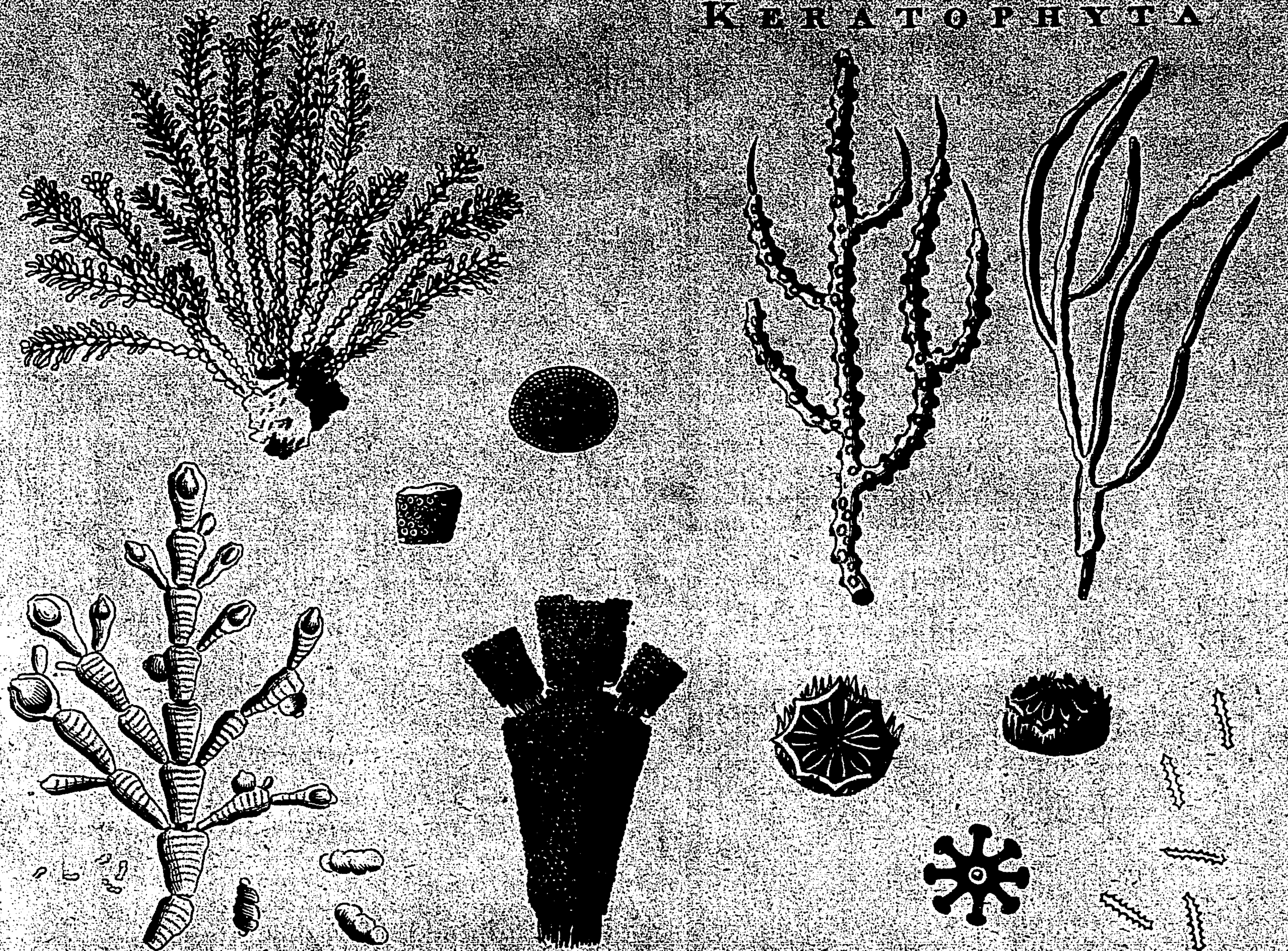




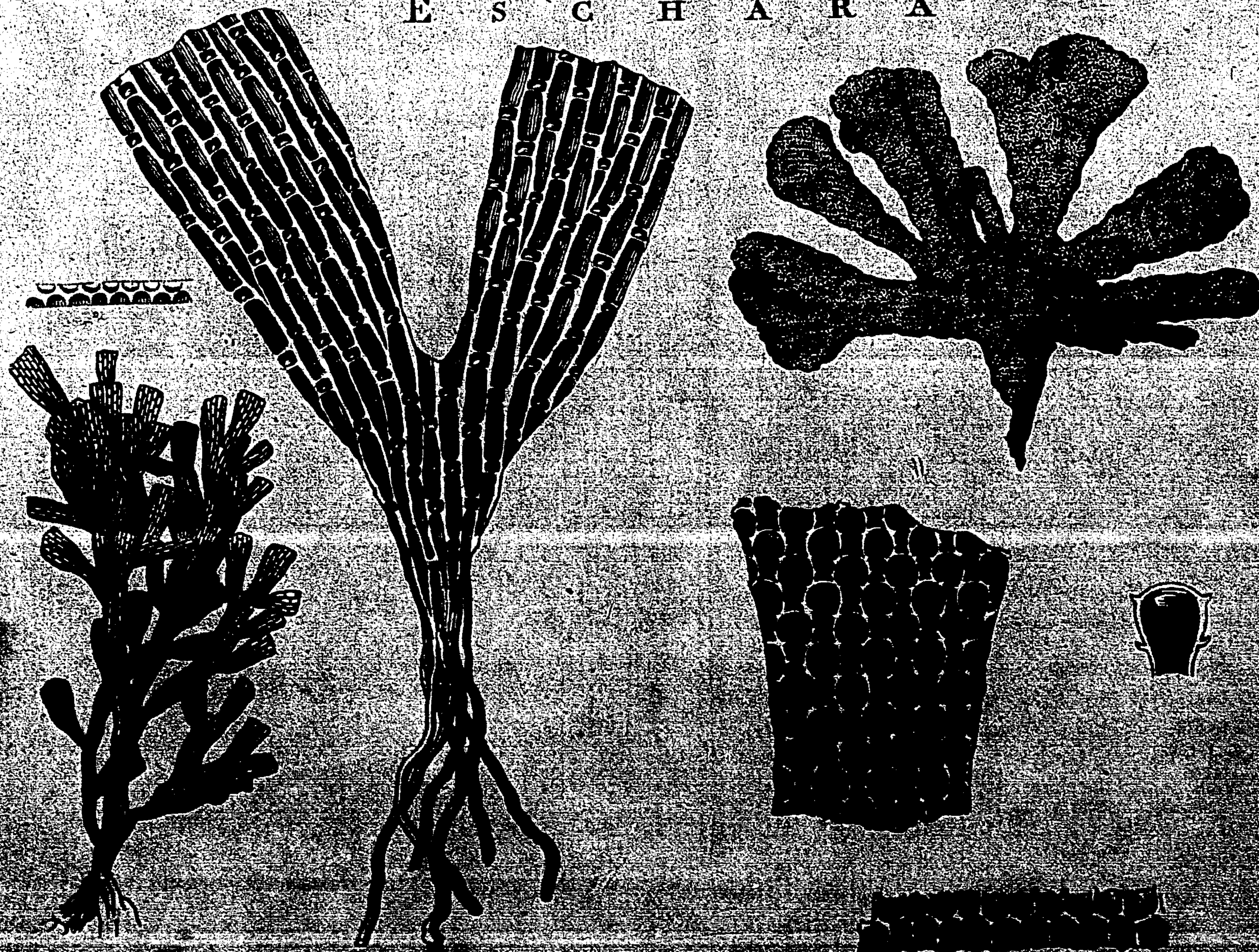
CORALLINES.

ARTICULATED

KERATOPHYTA



ESCHARA





this, there are others of equal importance to the well-being of plants and fruits; the first is, that of the foot-stalks and leaves nourishing, and preparing the buds of the future shoots, which are always formed at the base of those foot-stalks, and during the continuance of the leaves in perfect health, these buds increase in their magnitude; and, in the deciduous trees, are brought to maturity before the foot-stalks separate from the buds in autumn; but if by accident the leaves are blighted, or if the entire surface of the leaves are cut off, and the foot-stalks are left remaining, the buds will decay for want of that proper nourishment which is conveyed to them from the leaves: so that whenever trees are divested of their leaves, or those leaves are cut, or otherwise impaired, though it may in either case happen when the buds may be nearly formed, yet if it is before the foot-stalks separate naturally from their branches, the future shoots will be weakened in proportion to the time when this is done; therefore from all the experiments which have been made in order to know how serviceable the leaves of trees and plants are to their well-being, it has been found, that when the plants have been divested of their leaves, or their leaves have been eaten or cut, during their growth, the plants have been remarkably weakened thereby. This should teach us not to pull or cut off the leaves of trees, or plants, on any account while they retain their verdure, and are in health; and this shews how absurd that common practice is, of feeding down wheat in the winter and spring with sheep; for by so doing, the stalks are rendered very weak, and the ears are in proportion shorter; nor are the grains of corn so plump and well nourished, as that which is not fed down upon the same ground: this is a fact which we can assert from many years experience. It is very evident, that grass which is often mowed, the blades will be rendered finer in proportion to the frequency of mowing it, yet the species of grass is the same with that on the richest pastures; so that although this may be a desirable thing for lawns, &c. in gardens, yet where regard is had to the produce, this should be avoided.

Another principal use of the leaves, is to throw off by transpiration what is unnecessary to the growth of the plants, answering to the discharge made by sweat in animal bodies; for as plants receive and transpire much more, in equal time, than large animals, so it appears how necessary the leaves are to preserve the plants in perfect health; for it has been found by the most exact calculation, made from repeated experiments, that a plant of the sun-flower receives and perspires, in twenty-four hours, seventeen times more than a man.

**MOSSSES.**

THEIR genera, or different kinds, are so distinctly described in the three plates given of them; and these are so accurately and beautifully executed, as would render a scientific account of them here tedious and unnecessary. A mere inspection by any one acquainted with the subject of Botany, will be sufficiently informing, and entirely satisfactory.

**OF FOSSILS.**

IN our Natural History of Waters, Earths, Minerals, &c. page 387, we have treated this subject in a copious and comprehensive manner; and our survey of nature, and her treasures, has been such, that all, even the illiterate, may learn those truths, the know-

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**MICROSCOPICAL OBJECTS.**

OF these we have given three exceeding curious plates. The first contains Chrystallizations. — Marine Salts. — Essential Salts of Plants. — Silver dissolved in Aquafortis. In the second and third plates are distinguished, under two classes, Animal and Vegetable subjects. Among other curious objects in the first class, are, the circulation of the blood—a Flea—a Loue—Polipe—Darts of the Gnat, and a number of animalcules. The second class exhibits the Parinæ of plants, also seeds and sections of the same. Their names are well known, and most of them having been described in the body of this work, a further explanation would be superfluous.

**SHELL-FISH and SHELLS.**

IN treating this subject, having been too concise and short, we must beg leave to introduce here the following addenda:

We observed, page 248, that Shell-Fish are usually divided by naturalists into crustaceous and testaceous animals. Crustaceous fish, such as the Crab and the Lobster, are furnished with a shell that is not of a stoney hardness; whereas testaceous fishes, like the Oyster and the Cockle, are furnished with a shell of a stoney nature, which is brittle and incapable of yielding.

Sea-Locust or Prawn, named in the plate of crustaceous animals, *Locusta Marina Indica*, has two large feelers placed before the eyes.

Elephant-Lobster. This is shaped pretty much like a common lobster, only the fore claws are longer, and the nippers, which are thinner and broader, open wider than in any of this kind.

Cray-Fish (the River) differs only from some Lobsters, in being less.

Shrimp. The common is the smallest of this kind. In the East-Indies is one that grows to be near a span in length, and has a shell like ours.

Crabs. Their varieties are numerous, as will appear from the plate, and the Natural History of them, page 249.

**OF TURBINATED SHELL-FISH.**

They are somewhat in the shape of a top, and are surrounded with spiral furrows, much like a screw, being wide at the mouth, and terminate by degrees in a point. Within they are all nearly alike with regard to their surface, which is exceeding smooth; of these kinds are—

The Nautilus, or Sailor; one of which is a small sort, and comes out of its shell; but the other keeps to its shell like a snail, or at least seldom comes out of it.

Pearl Shelled Nautilus; so called from having a shell exceeding bright on the inside.

Little Thick Nautilus, is of a roundish form, and rarely exceeds an inch and a half in diameter.

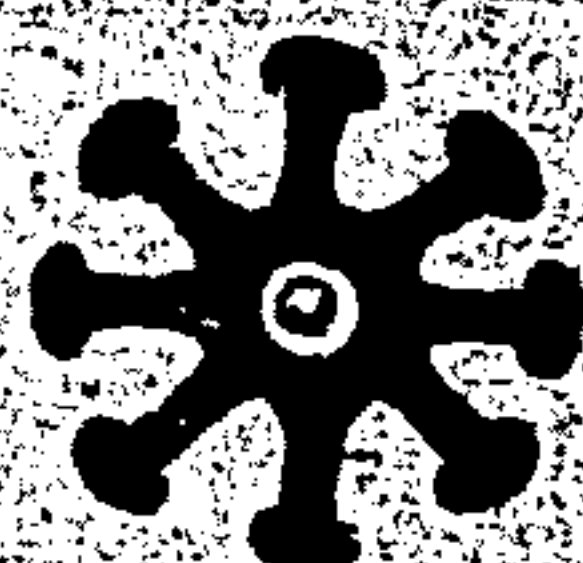
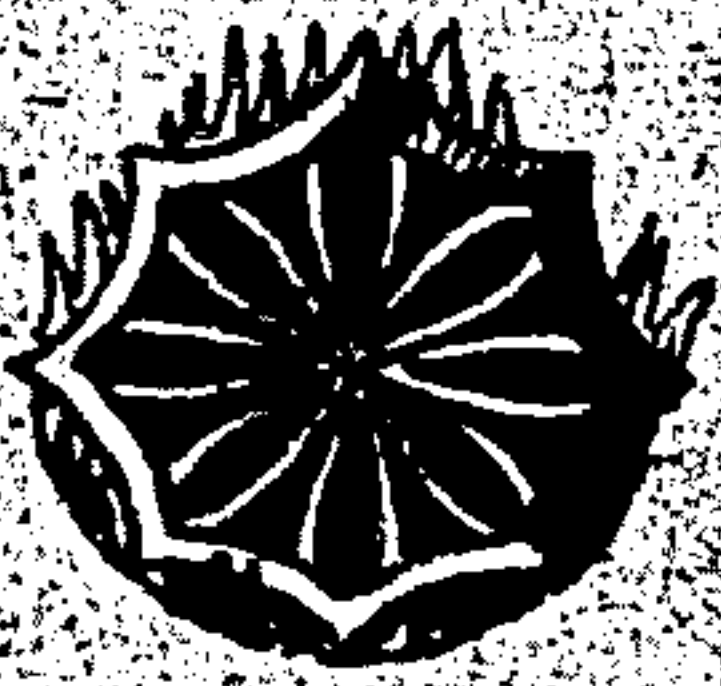
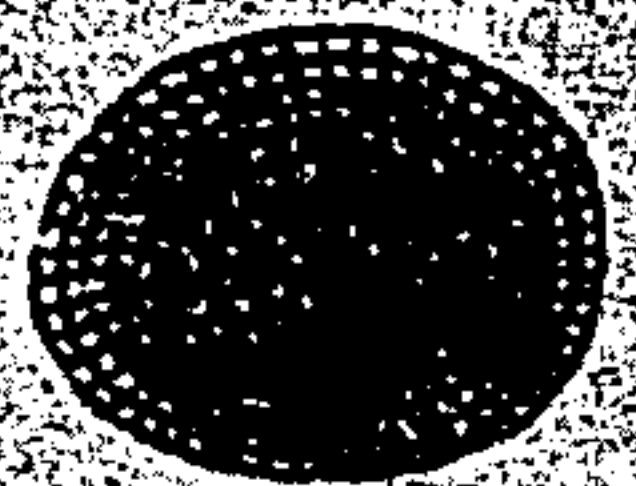
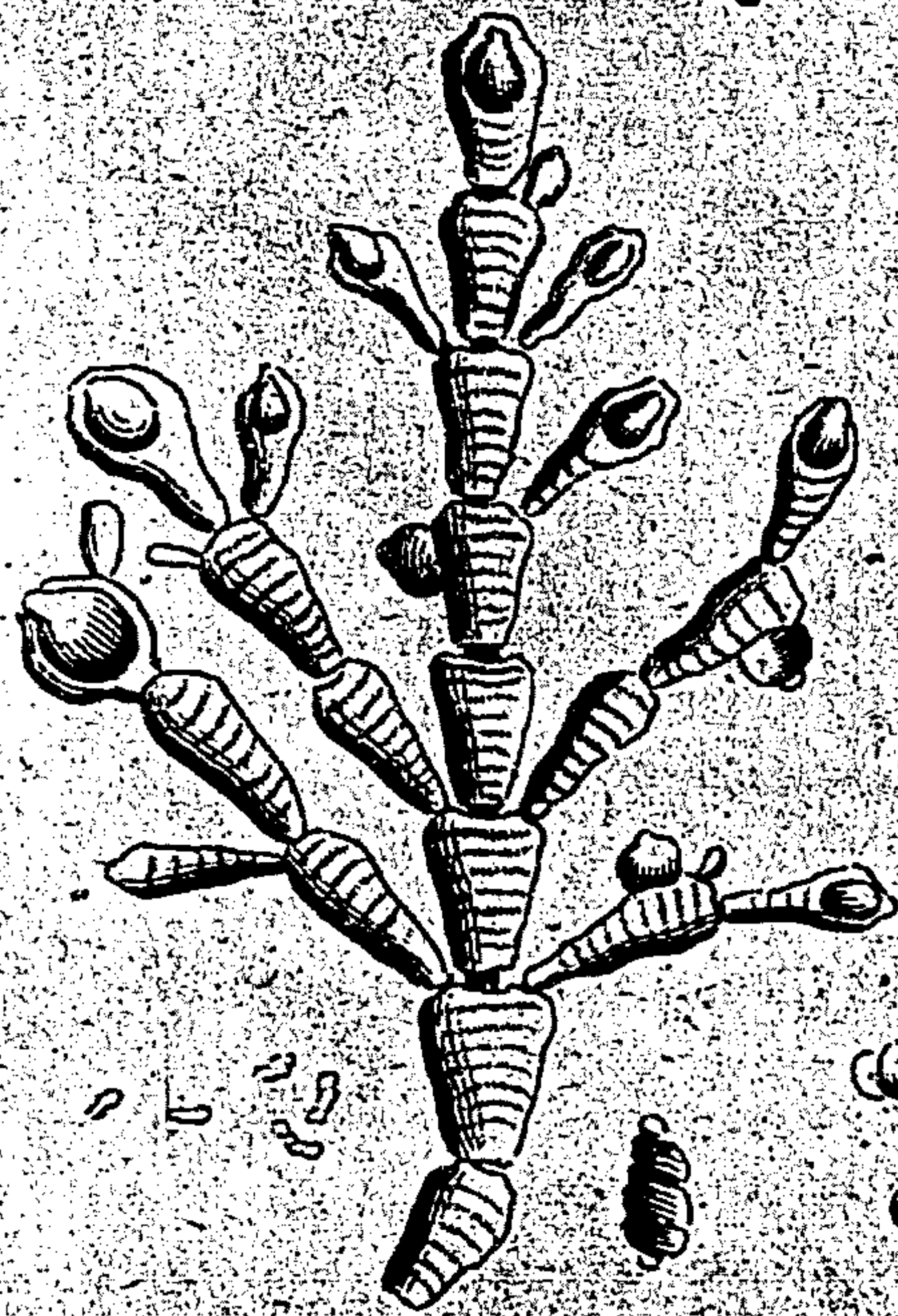
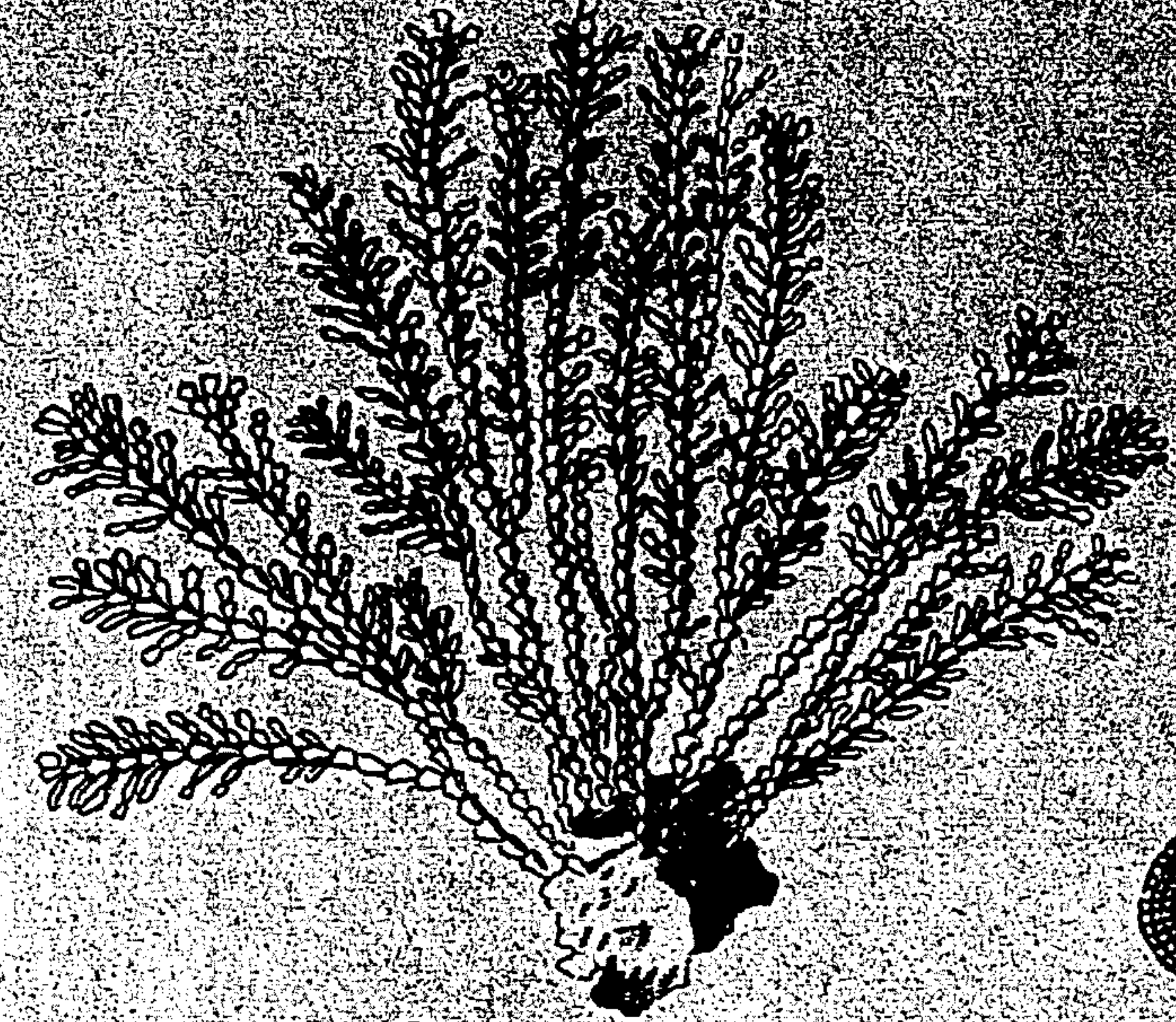
Thin



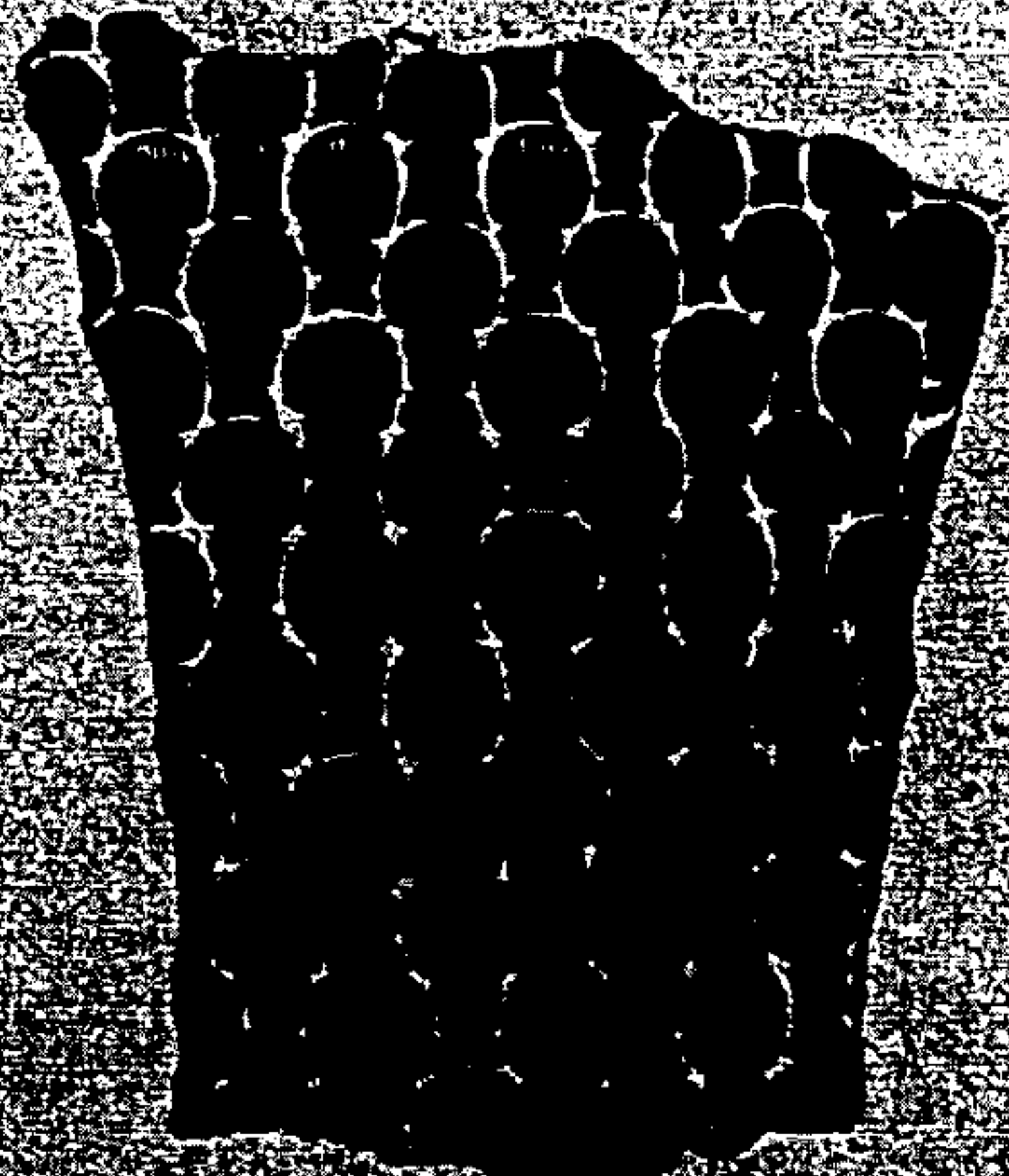
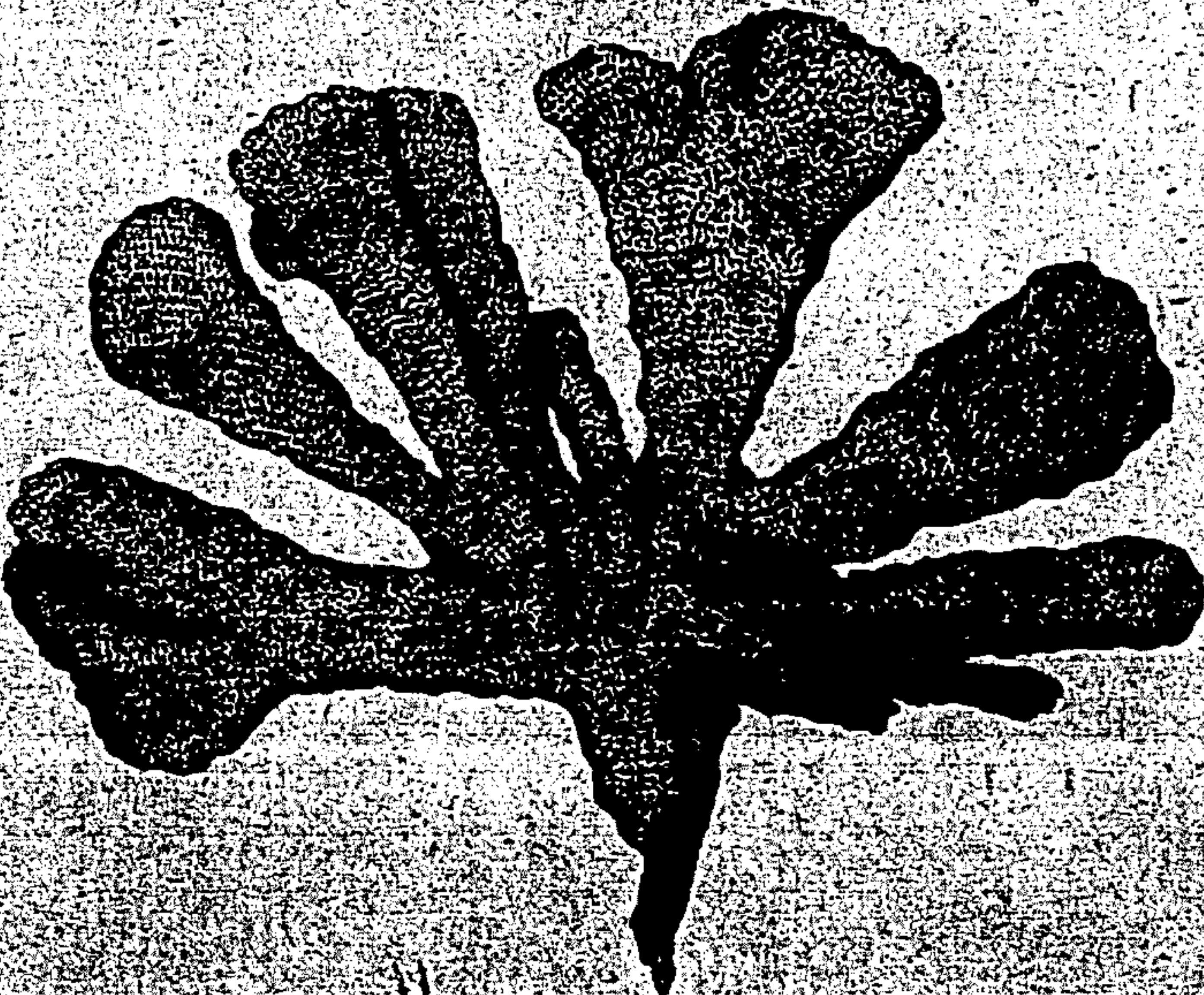
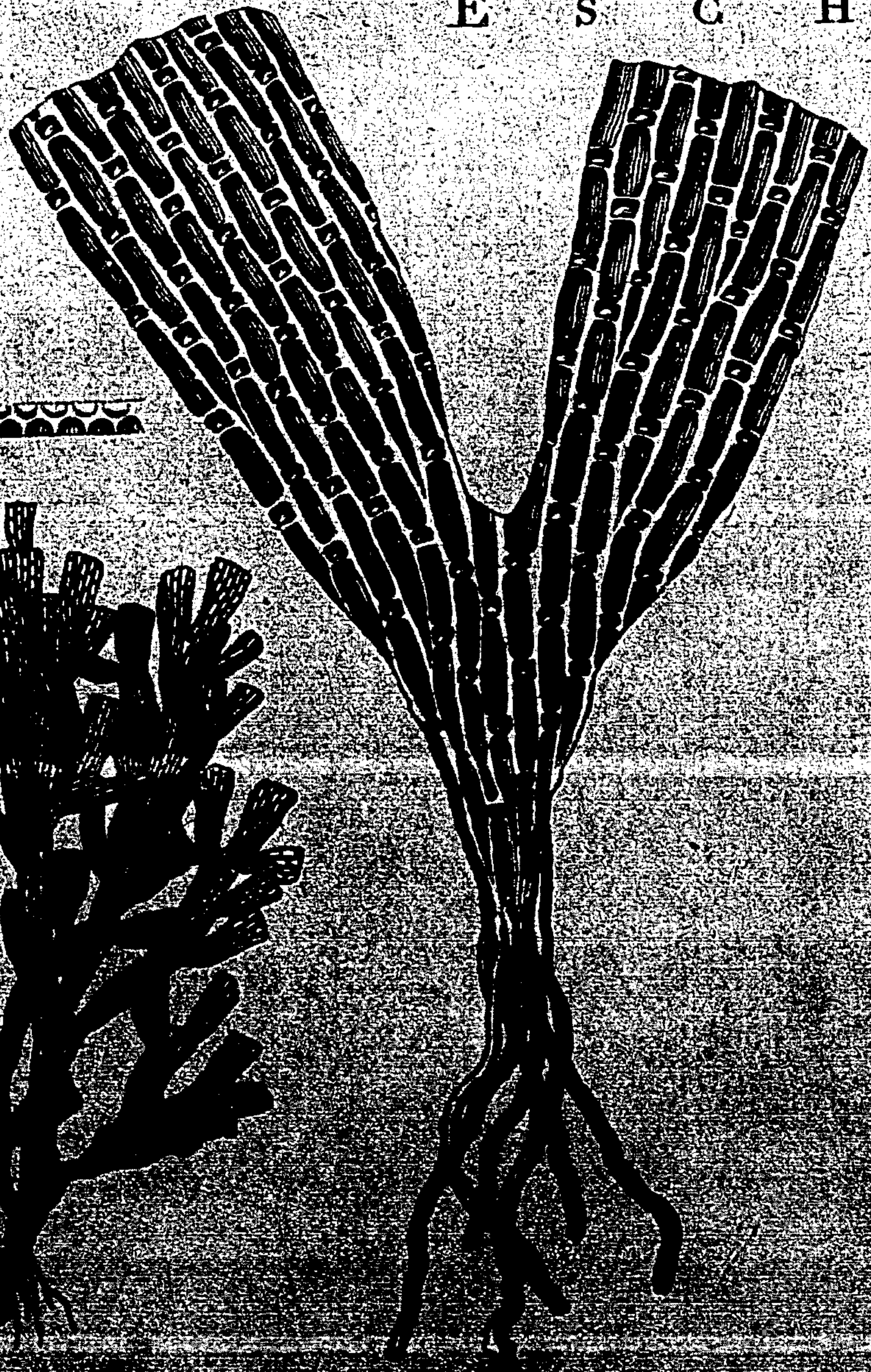
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Little Thick Nautilus, is of a roundish form, and rarely exceeds an inch and a half in diameter.



Thin Eared Nautilus has a very beautiful shell, which grows to ten inches in length, and is exceeding thin.

Paper Nautilus, so called from the thinness of its shell, is often met with twelve inches long, and is compressed on the sides.

Thin Nautilus without Ears, is smaller than the former kind, for it is but five inches long, and three or four deep.

Purpura is of the size of an egg, and sometimes bigger. There are several sorts of them, as—the yellow Long-snouted, with long crooked spines—The variegated Long-snouted, nearly of an oval shape—The Short-snouted, about two inches long, and its diameter, with the spines and thorns, is an inch and a half—and that with three rows of spines is about three inches long, including the spines, and as much in diameter.

Trumpet Shell, called Buccinum, from its imaginary likeness to a trumpet or horn.—One of the island of Goree, which is seldom above half an inch long, and its breadth is less by one half.—Another of Senegal: It is composed of ten turns or spires; which are all smooth, polished, and flatted, except the first; but they are not very distinct from each other.

The Hedge-Hog Murex is three inches and a half long, and about two and a half broad, where thickest.—One with a smooth clavicle, is two inches and a half long, and near two in diameter where broadest.

Ribbed Music Shell. Its body is short, and there are several low ribs at some distance from each other. It is a native of the East Indies.

Gold-mouthed Cochlia or Snail. This is round, and edged on the circumference with a narrow lip. It is common in America.

The Snail has numerous varieties, as the Hedge-Hog—The Smooth Ribband—The Watery—The Smooth Brown—The Three Ribbed—The Toothed—The Banded—The Prickly—The Clouded—The Conical Tuberculated—The French-Horn.

Others of different kinds of Shell-Fish are noticed by authors; the distinct names of them will be found in the plates; to enlarge upon which, by a particular description, would extend this work to a tiresome length, and very far beyond our prescribed limits.

### OF TURBINATED SHELLS.

These are of a simple kind, consisting of one piece, and of a long slender make, always terminating in a very long fine point. The mouth is narrowest towards the base, and has a sort of an ear. They are of different shapes, and in general they are called Screw-Shells.

The Thick Turbo, or Screw-Shell, has an oval mouth, and consists of about fourteen turns, of which that next the mouth is the largest, from which they gradually diminish to the end which is pointed.

The Needle, or Slender Screw-Shell. This has roundish spires, and it becomes gradually smaller from the mouth to the other end, where it terminates in a point. It consists of sixteen spiral turns, which are all belled, rising very high in the middle. It has only a notch, where the ear is placed, and the whole surface is perfectly smooth. The colour is white, variegated with yellow.

The Turbo, or Screw-Shell, with belled spires and elevated ribs, is an inch and a half in length, and the largest turn a little more than the third of an inch in diameter. The colour is white, and the mouth round and pretty large, with a thick lip. It is common on the shores of Barbadoes.

The Conical Turbo, or Screw-Shell, with plain

streaked and numerous spires, is by some called the Telescope Shell.

The Slender Turbo, or Screw-Shell, with spiral lines on the turns, is four or five inches long, and scarce half an inch thick where thickest. The colour of the shell is yellow, unless it has lain long on the shore. It is found on the shores of the American islands, as well as in the East Indies.

The Turbo, or Screw-Shell, with distant and prominent spires, is about five inches long, and the diameter of the spire next the head, is about three quarters of an inch. The colour is whitish, with a tincture of yellow and red, and it is brought from the East and West Indies.

The Warty Turbo, or Screw-Shell, with a broad depressed mouth, called by some the Caterpillar-Shell, is about two inches and a half long, and near three quarters of an inch in diameter next the mouth. The shell in general is pale, variegated with a darker colour; but the protuberances are blueish. It is brought from China.

The Turbo, or Screw-Shell, with a long wide mouth, is three inches long, and of the thickness of a man's little finger. The colour is brownish, variegated with a deeper brown, and a reddish tawny. The surface is smooth, only there are a few tubercles on the second turn. It is brought from the East Indies.

The Oblong Mouthed Turbo, or Screw-Shell, with spires jagged at the edges, is about two inches long, and the third of an inch thick at the base. The colour is of a faint brown, a little variegated with tawny and reddish, and regular rows of little black dots. It is found in America, and some parts of Europe.

The Thick-Eared Turbo, or Screw-Shell, with turns deeply jagged at the edges, is three inches long, and in diameter, where thickest, an inch.

The Screw Shell of Senegal is like a cone rounded at the base, and grows gradually smaller to the top, where it terminates in a very fine point.

### OF WREATHED SHELLS.

The Voluta are of one piece, and of a figure nearly conical, but short, the clavicle being commonly depressed; and the mouth long, perpendicular, and narrow.

The Jamar, is a Voluta of Senegal, very thick, and nearly of a conical shape. A membranous skin of a reddish colour surrounds the whole surface of the shell, and when this is taken off, it appears of a fine polish, and beautifully variegated with different colours. The ground is white, red, yellow, or brown, marbled with spots without any regularity, and sometimes encircled with pointed streaks. This shell is highly valued by the curious, who have given it different names, according to the varieties.

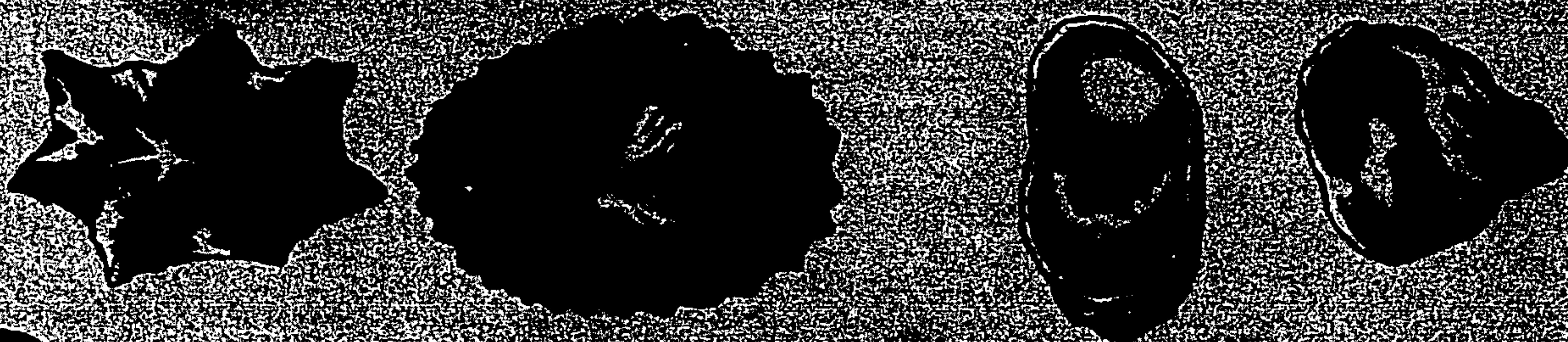
The Admiral Shell, or Voluta, with a broad yellow band, and a pointed line thereon, is an uncommon and very beautiful shell, bearing a great price. It is about two inches long, and near an inch in diameter towards the head, from whence, to the extremity of the mouth, it gradually decreases in size, so as to form a sort of a cone, with an obtuse point. The clavicle also diminishes in diameter, and terminates in a blunt point. The ground colour of the shell is of a beautiful yellow, but so variegated, that it does not take up above one third of the surface. There is a circle or ring of this colour at the head, of about the breadth of a straw, and below it there are three broad belts or rings finely variegated. The lowest of the three are broader than the others, and separated by five yellow lines. Under the belts the fine yellow again makes



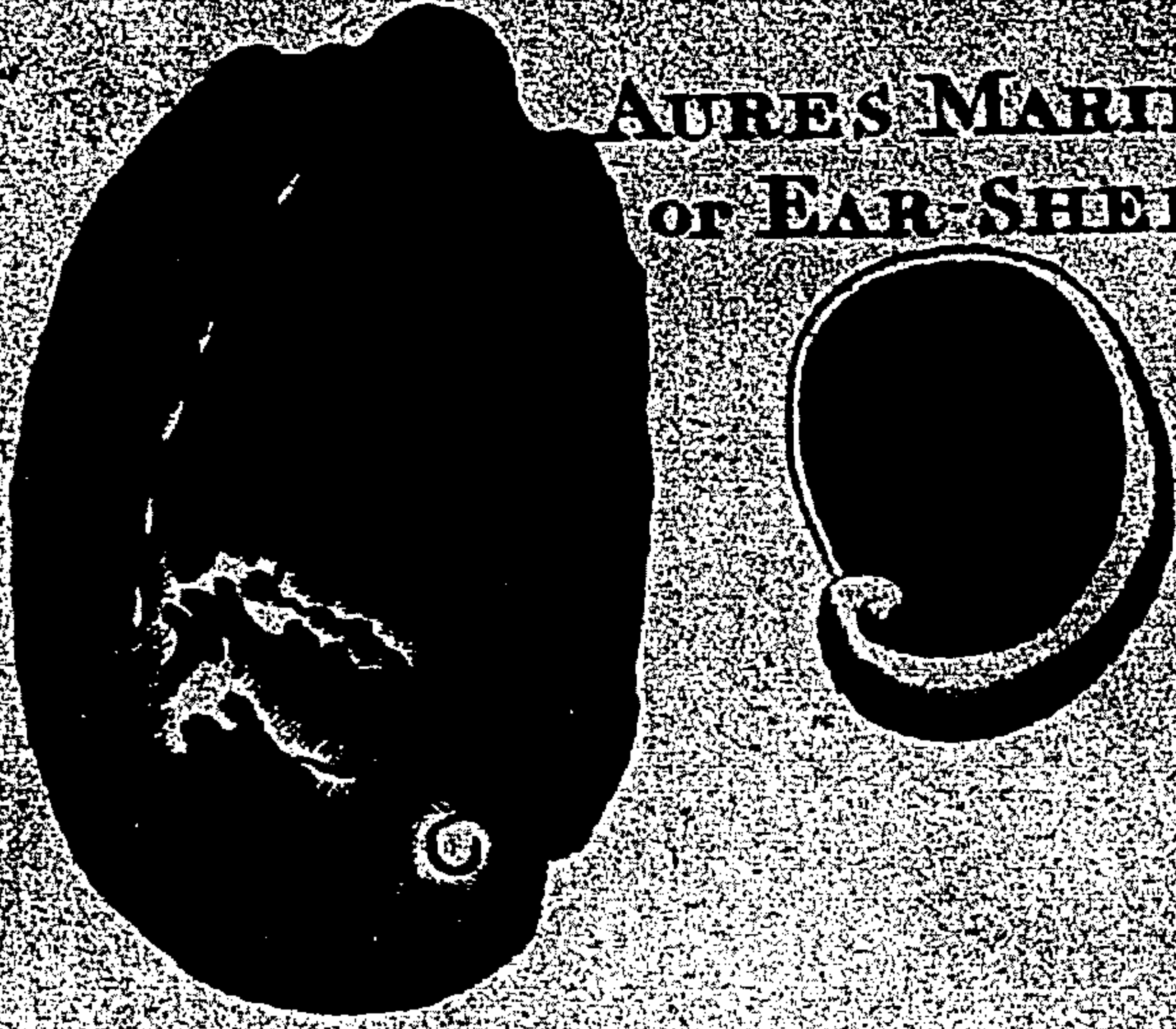




PATHEES OF LIMPETS



AURES MARINÆ  
OF EAR SHELLS



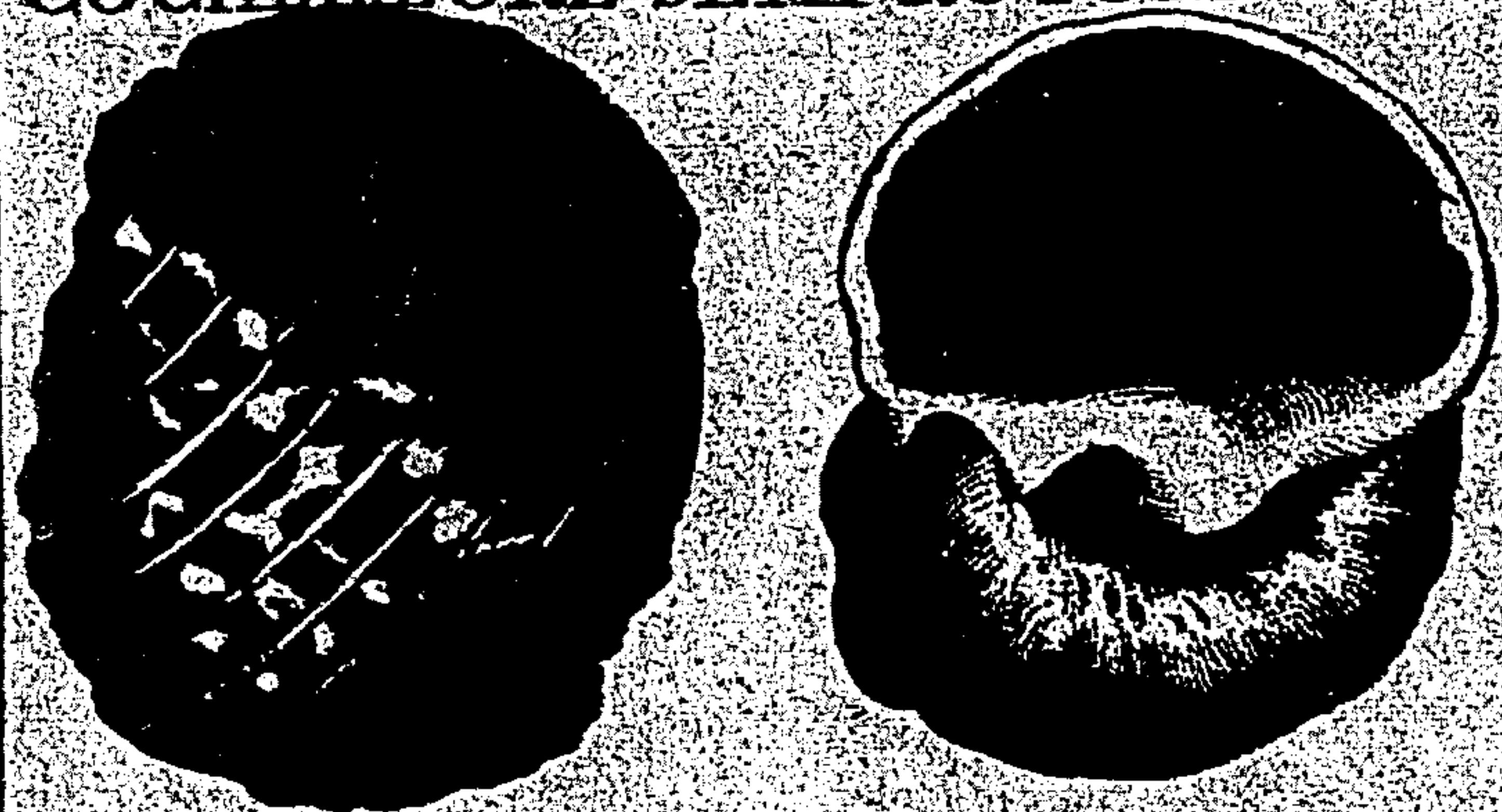
DENTALLIA



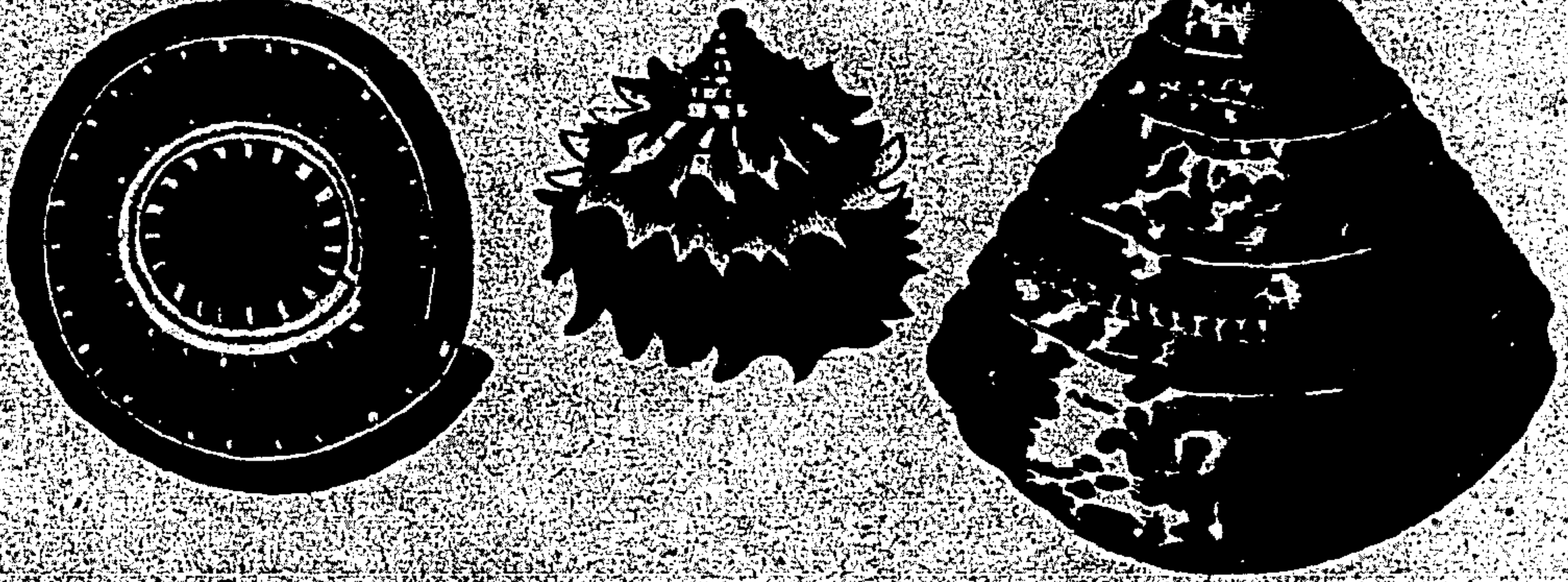
COCHLEÆ ORE ROTUNDO



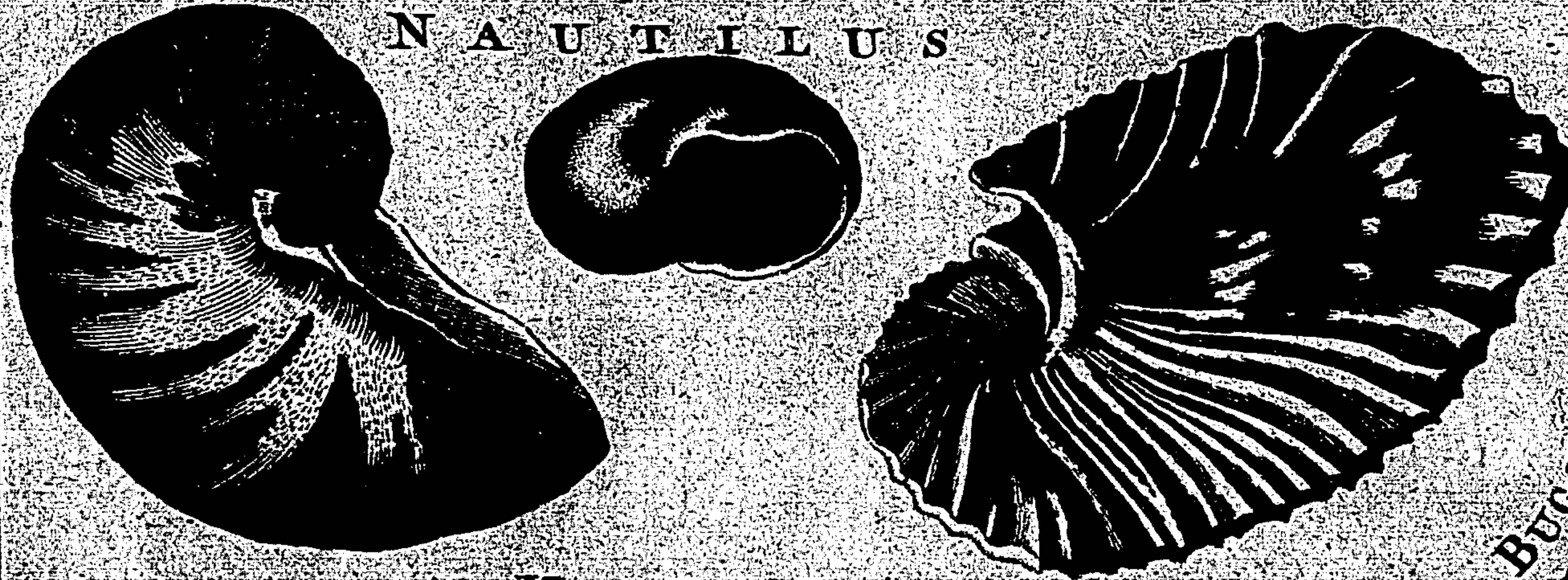
COCHLEÆ ORE SEMI ROTUNDO



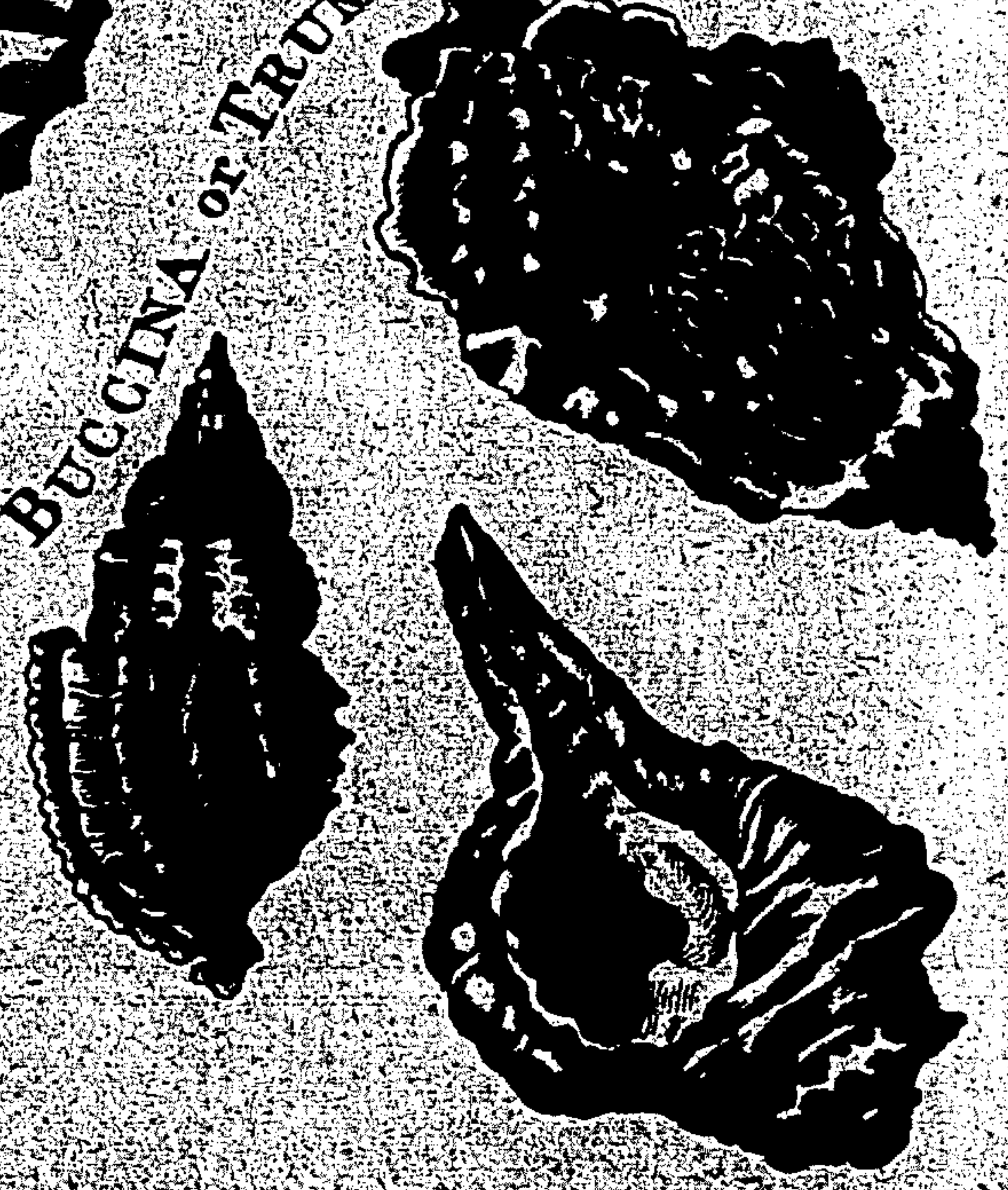
COCHLEÆ ORE DEPRESSO



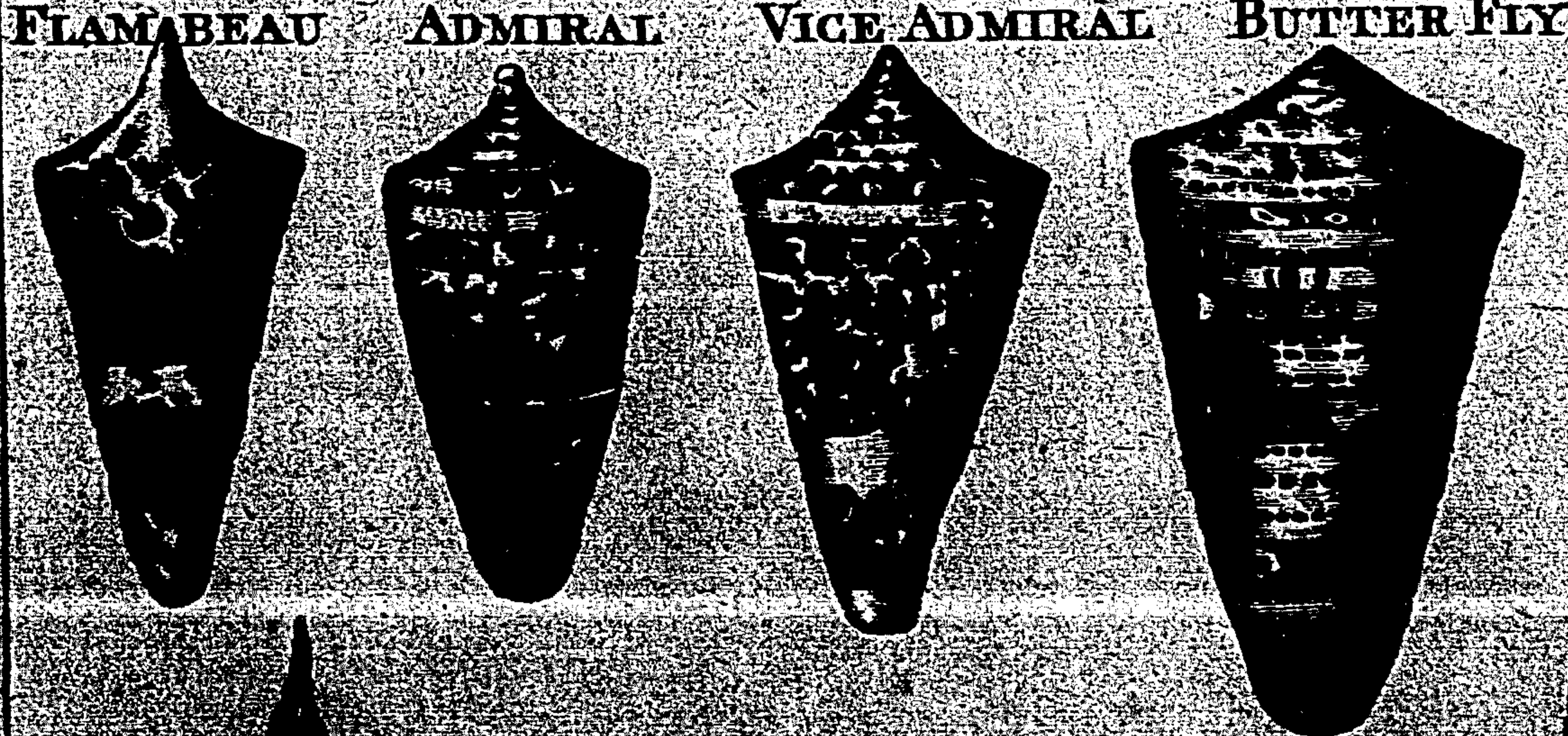
NAUTILLUS



BUCCINA or TRUMPET SHELLS



VOLUTÆ



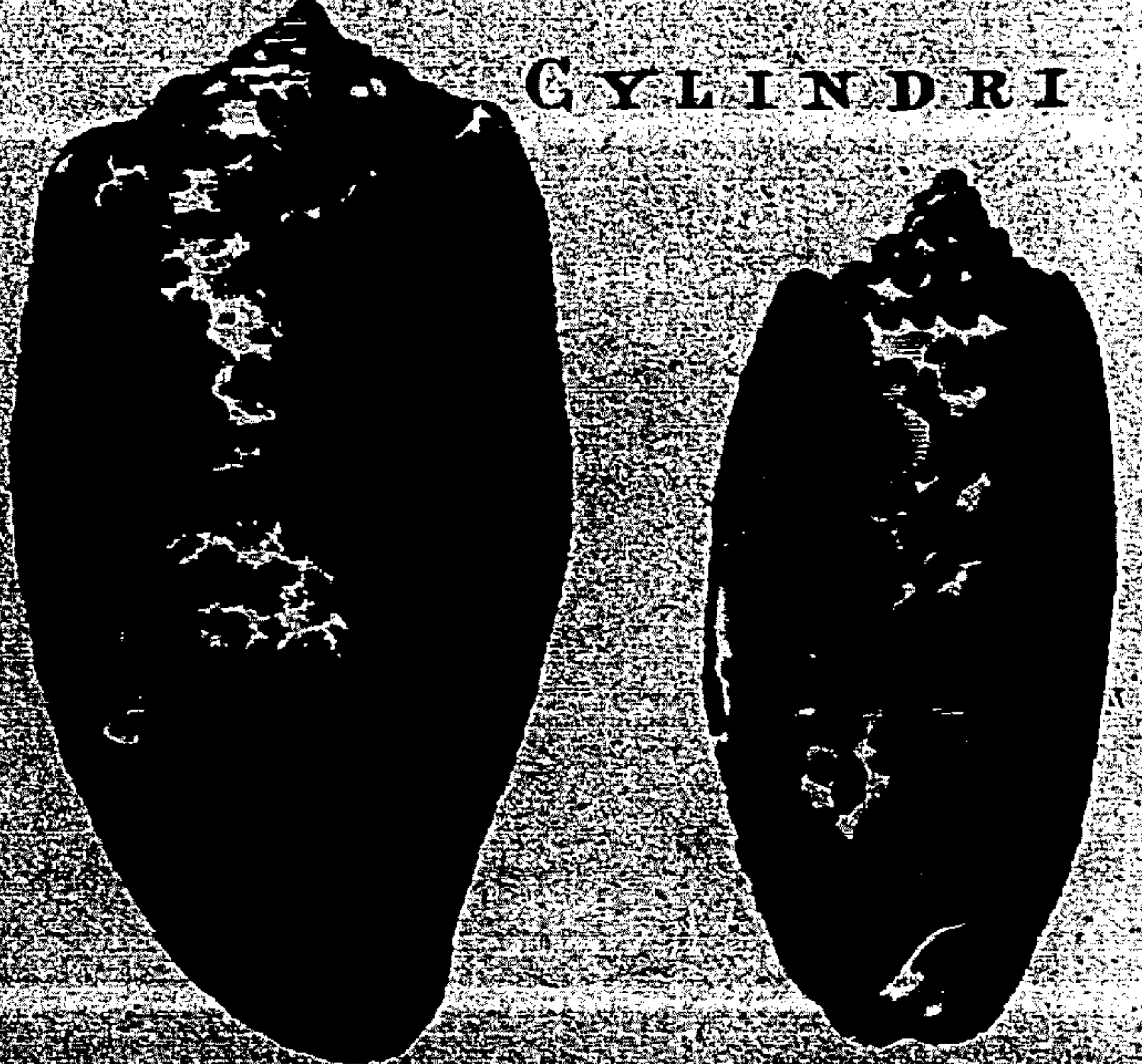
FLAMBEAU

ADMIRAL

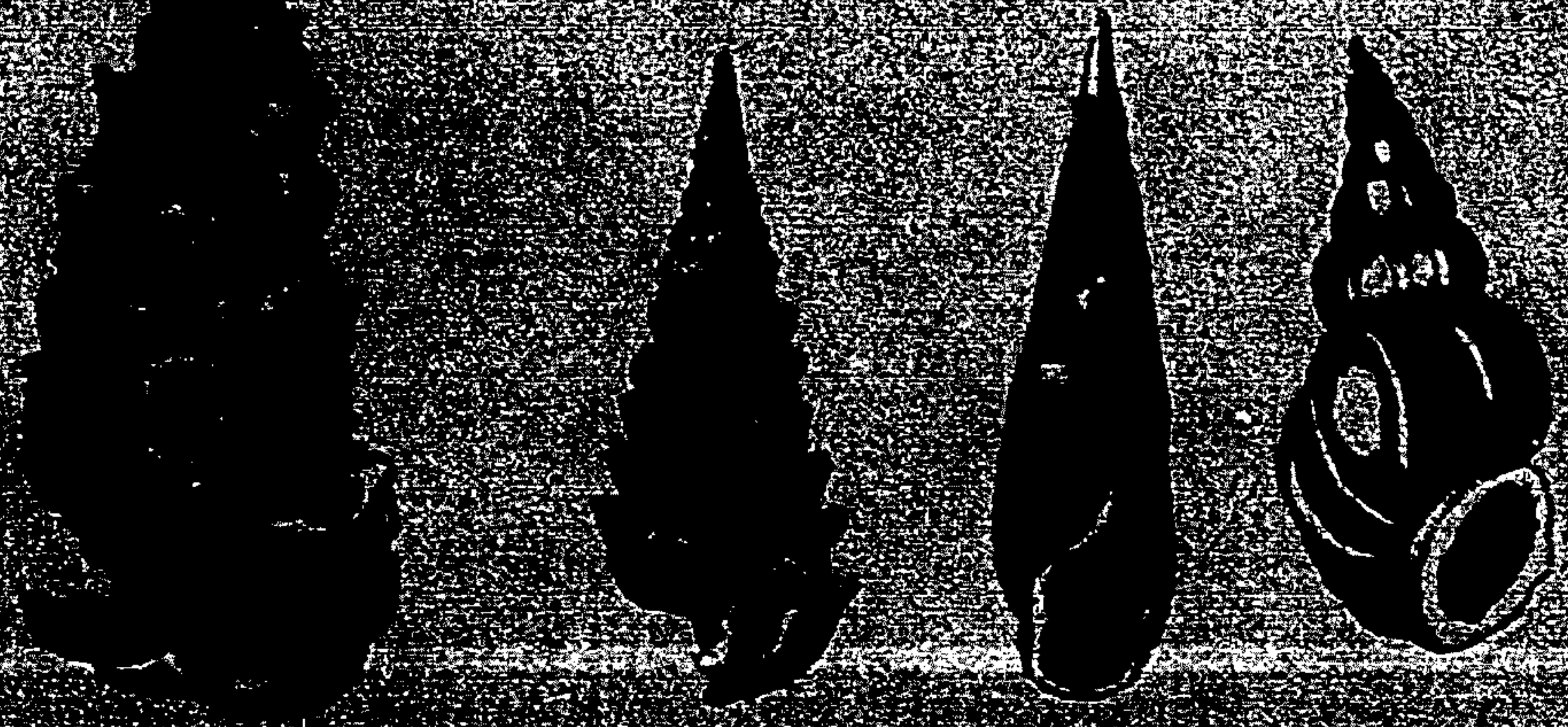
VICE ADMIRAL

BUTTER FLY

CYLINDRI



TURBINES





The United States

Department of the Interior

Geological Survey

Washington, D.C.

1900

Geological Survey

Department of the Interior

Washington, D.C.

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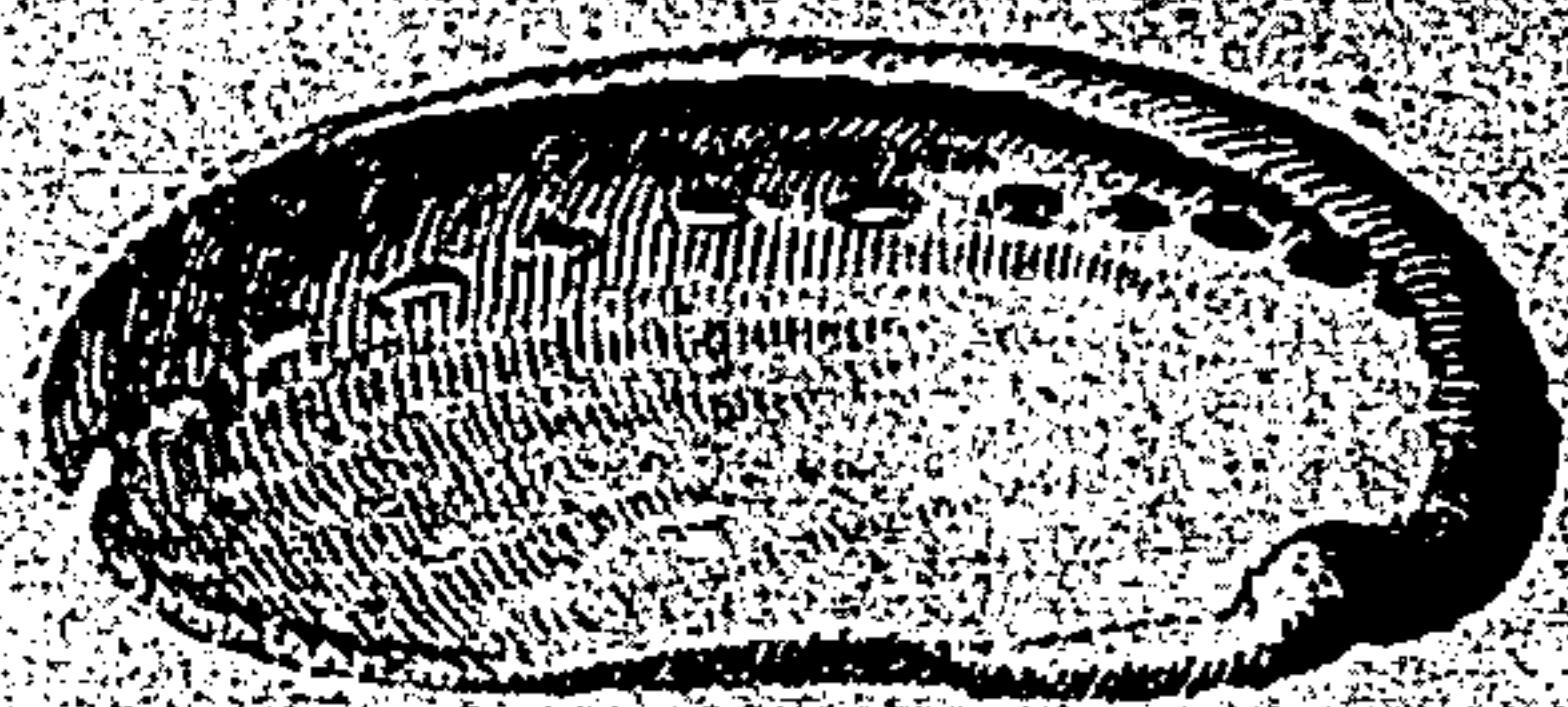
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# SHELL FISH



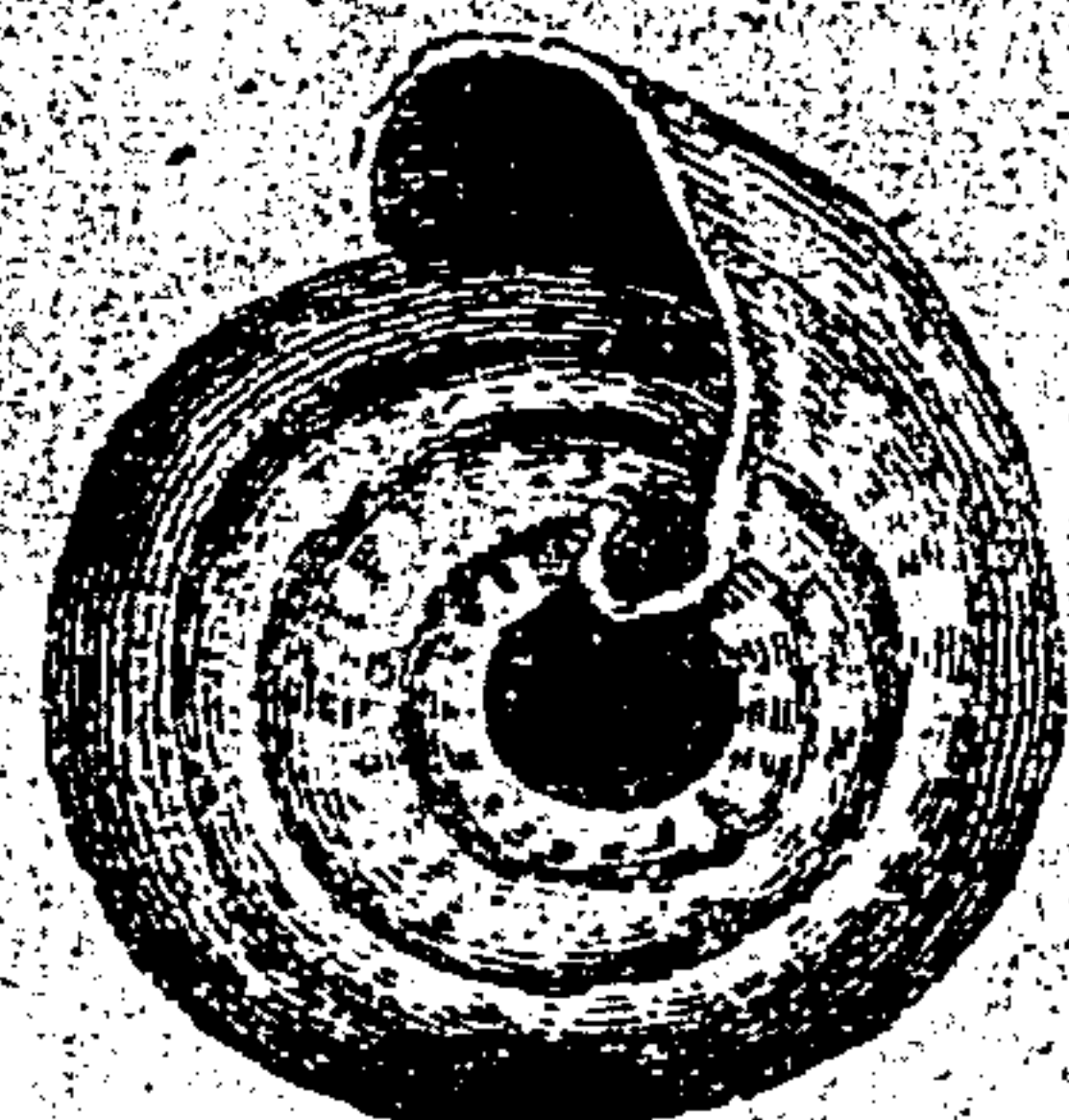
*The Long Ear Shell*



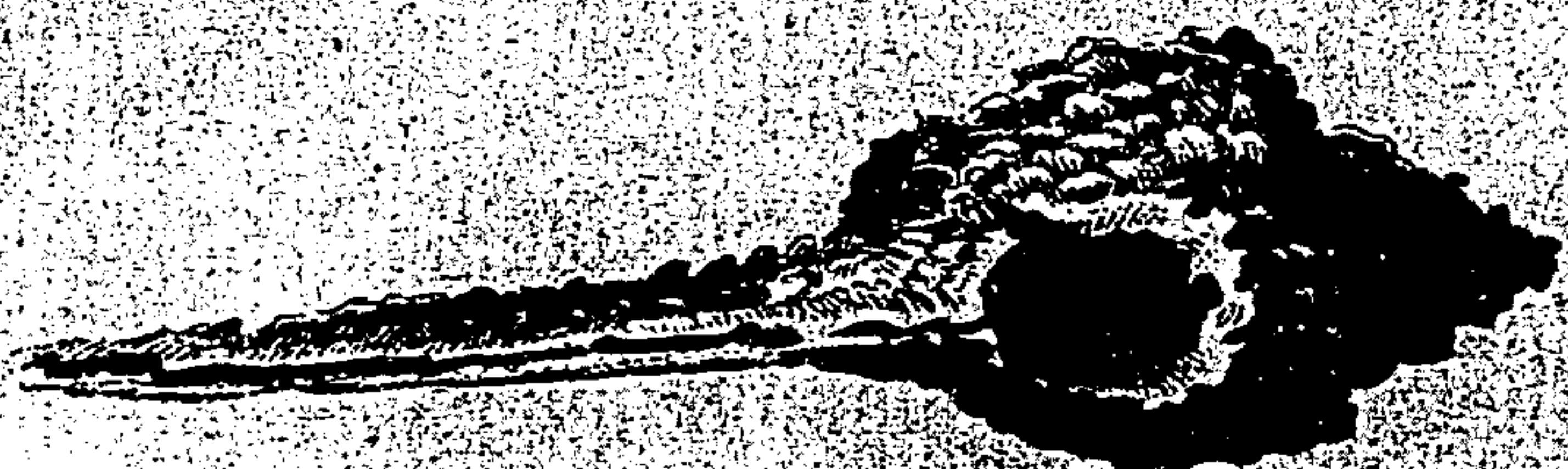
*The Narrow Mouth'd Grey Balanus*



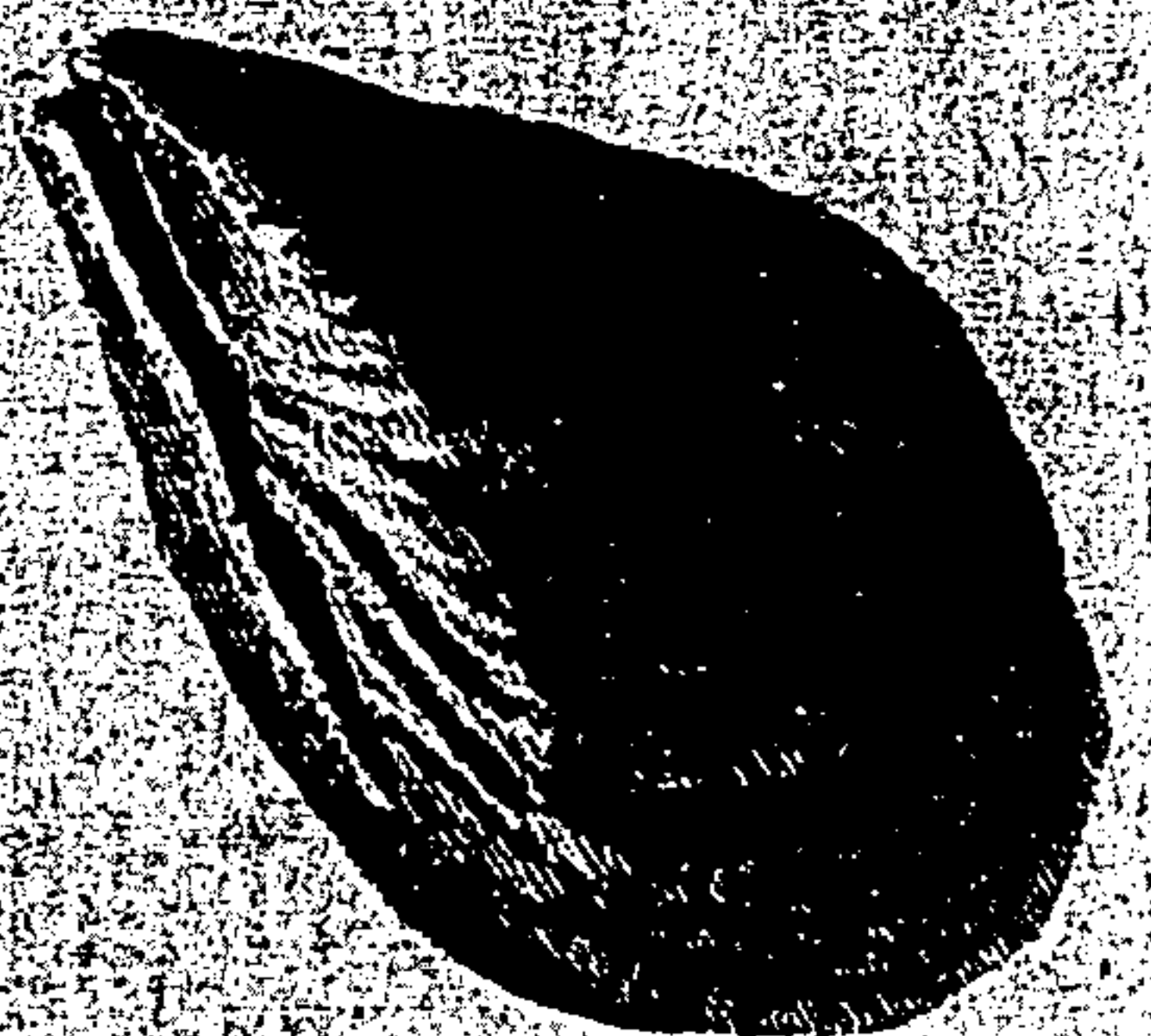
*The Boat Porcellane*



*The Cornu Ammonis Snail*



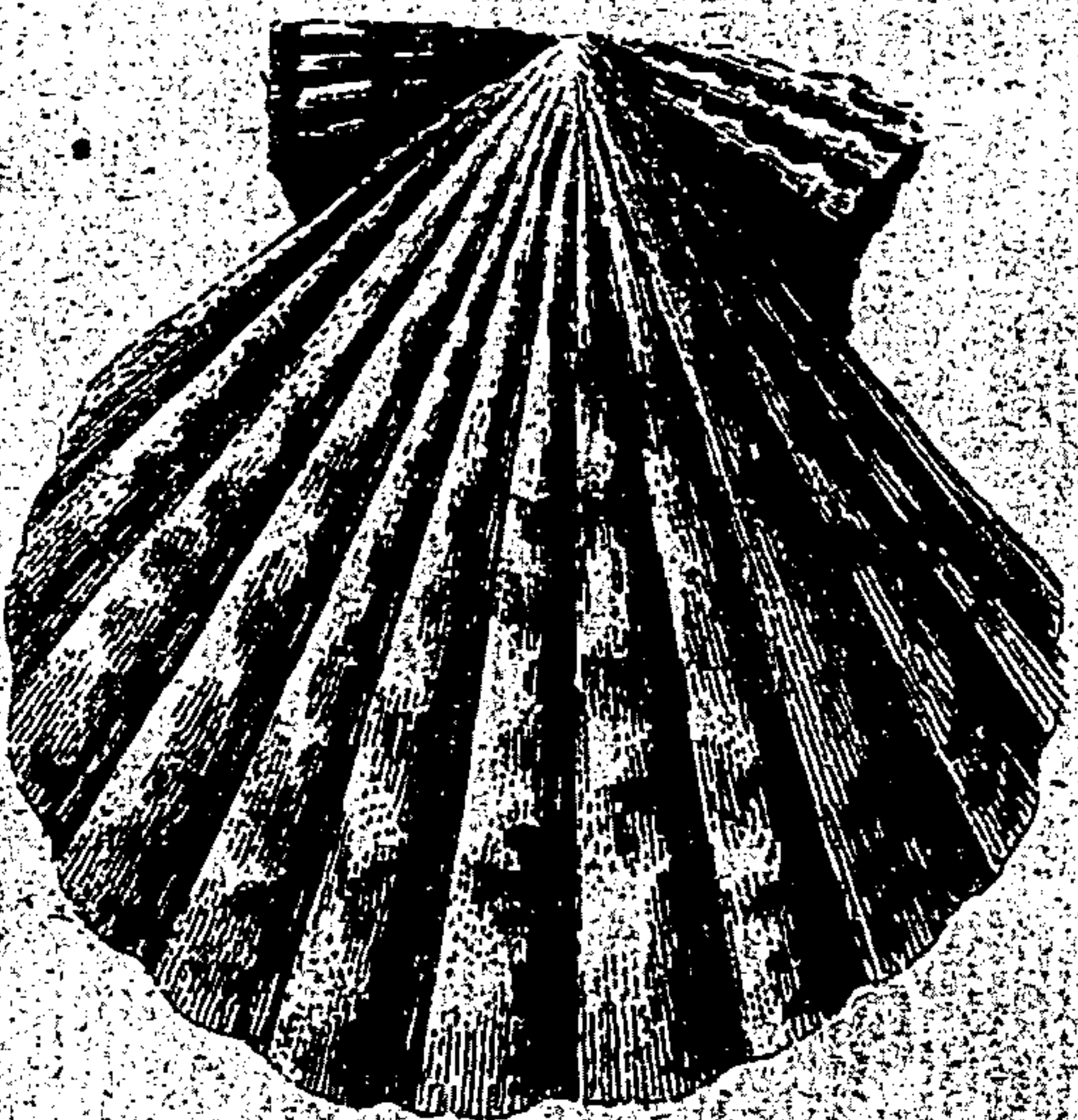
*The Common Woodcock Shell*



*The Magellanick Muscle*



*The Pointed-headed Porcellane*



*The large Rib'd Scallop*



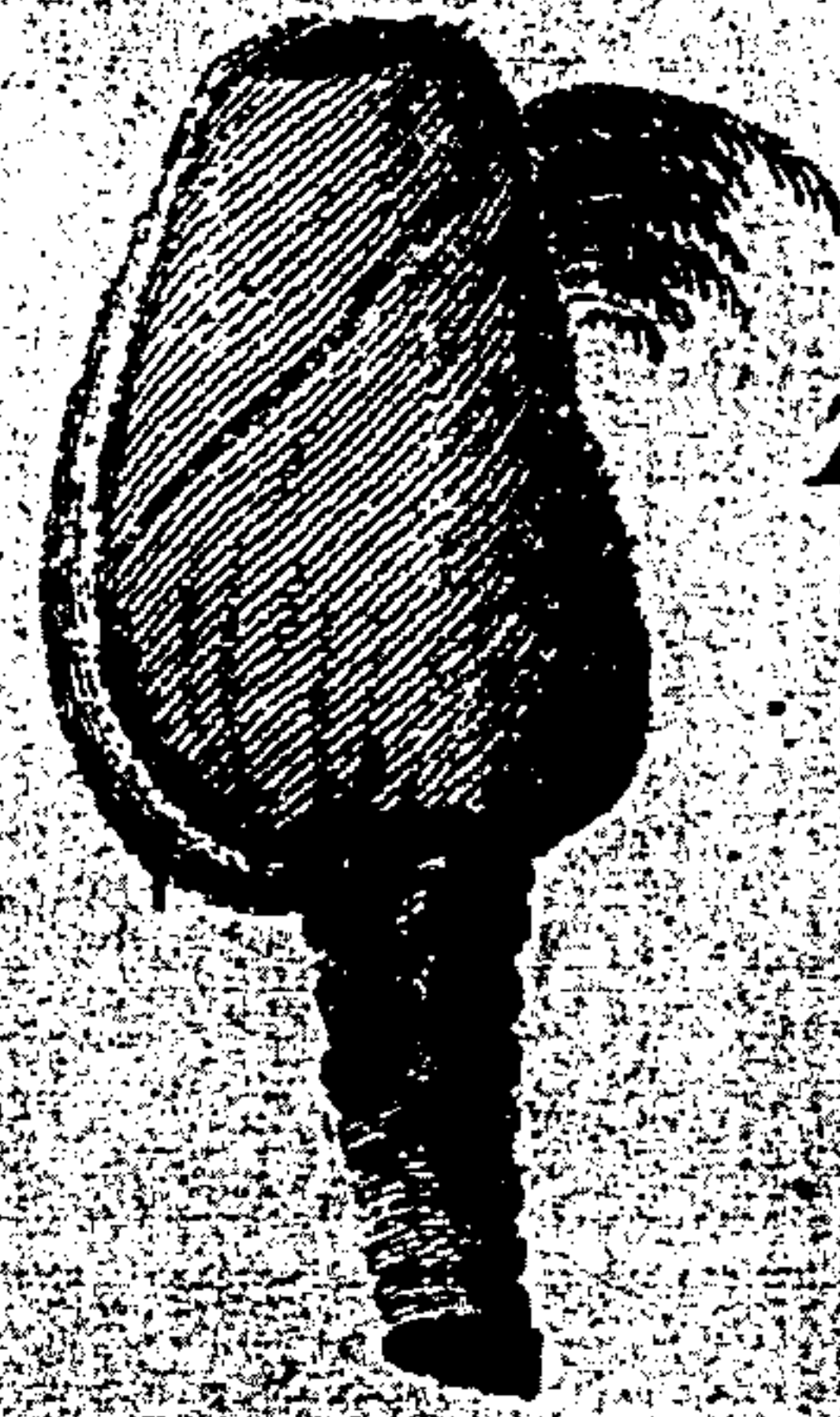
*The Pointed Murex*



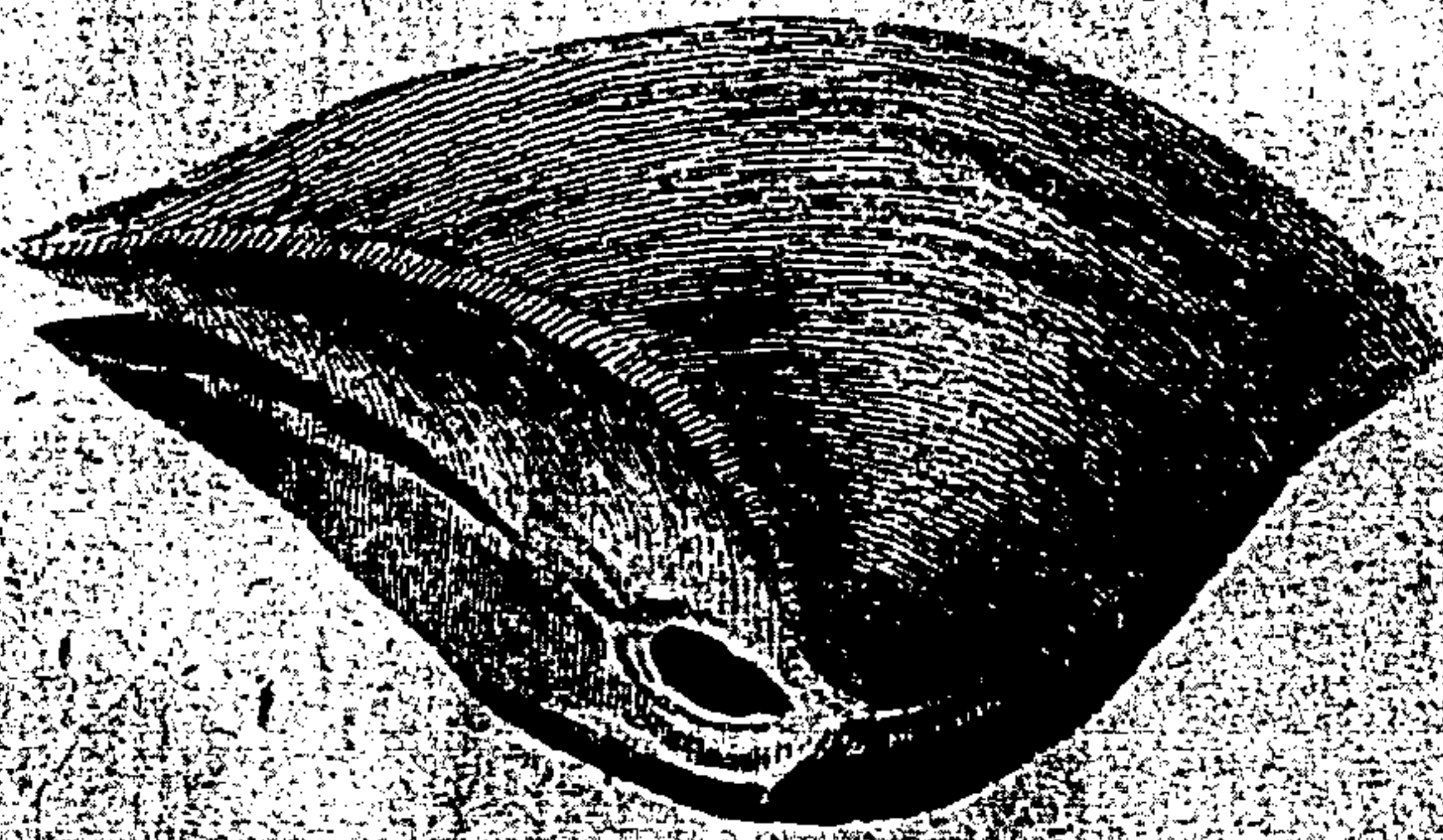
*The Agate Muscle*



*The high Lip'd Dolium*



*The Goose Shell*



*The Violet and White Chama*



*The Thick stem'd Goose Shell*



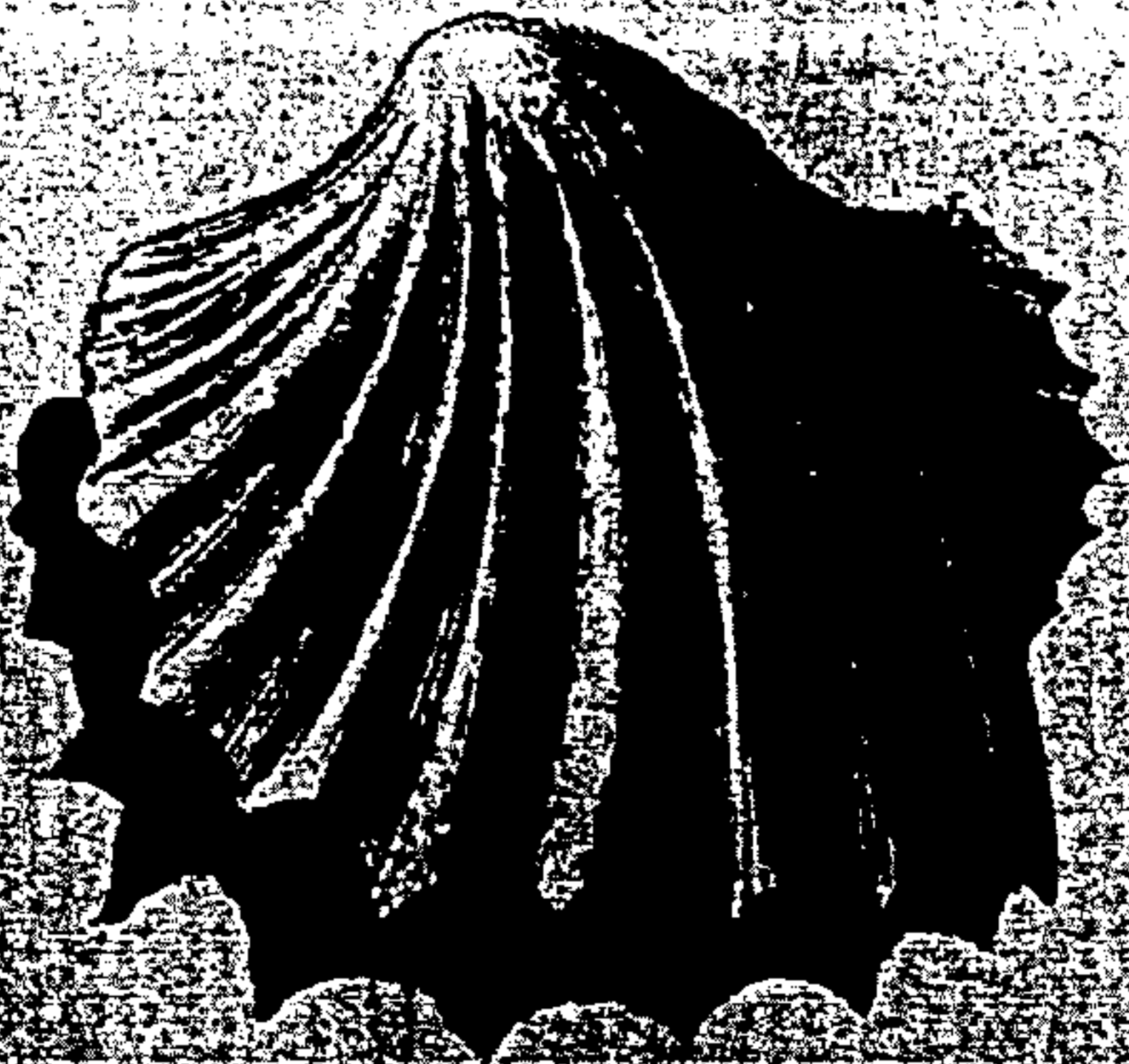
*The prickly Snail*



*Stomatium*



*The Yellow Zand Porcellane*



*The Exotic Heart Cockle*



*The Auriculated Paper Nautilus*



THE GREAT EASTERN ORDER

THE TOWER OF BABEL

THE BOOTH OF THE

THE GREAT EASTERN ORDER

THE CAROLINE MUSEUM

THE GREAT EASTERN ORDER

THE GREAT EASTERN ORDER



## SHELL FISH.



**THE RABB'D MUSICK SHELL**



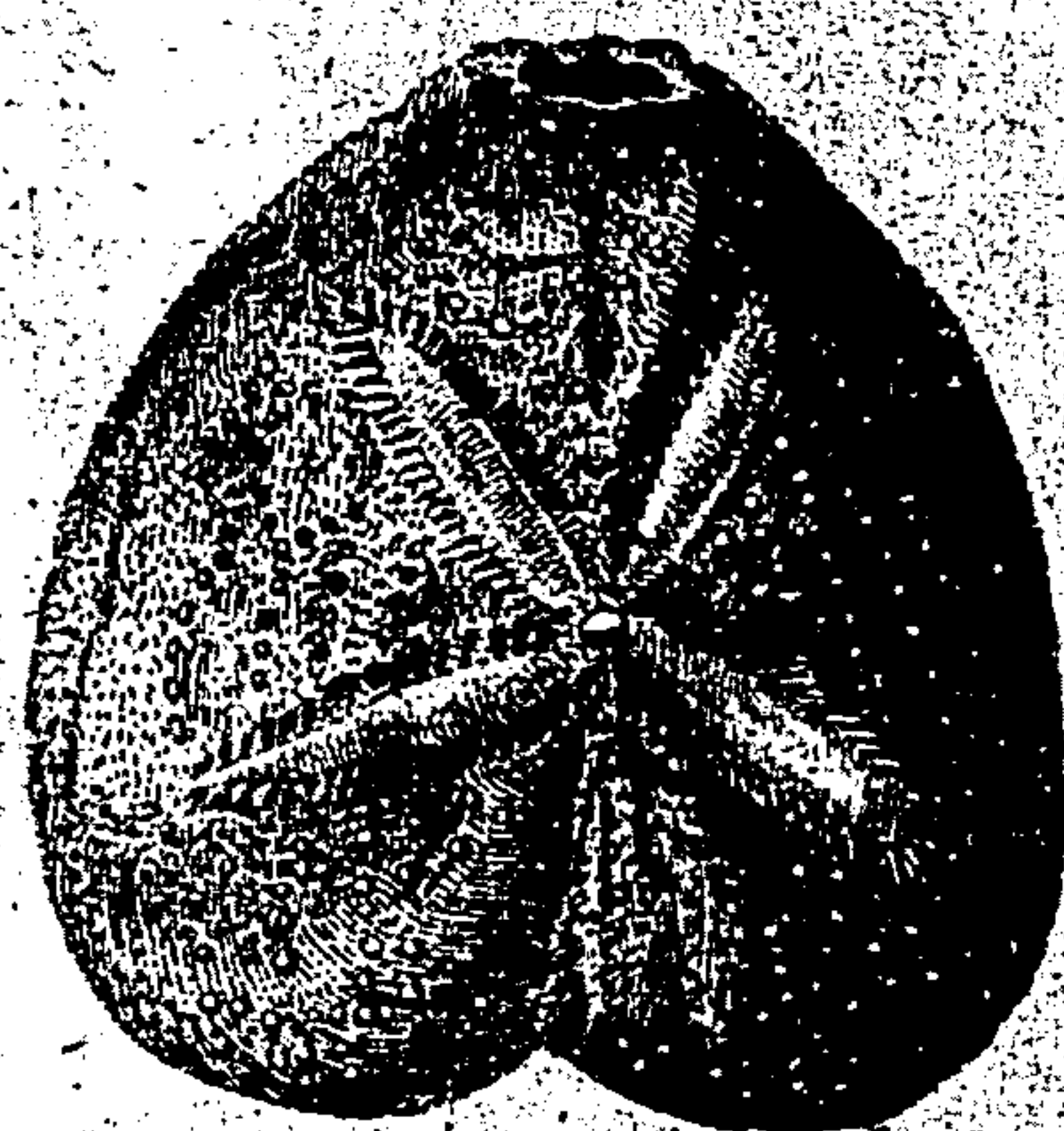
# THE CLOUDED OLIVE



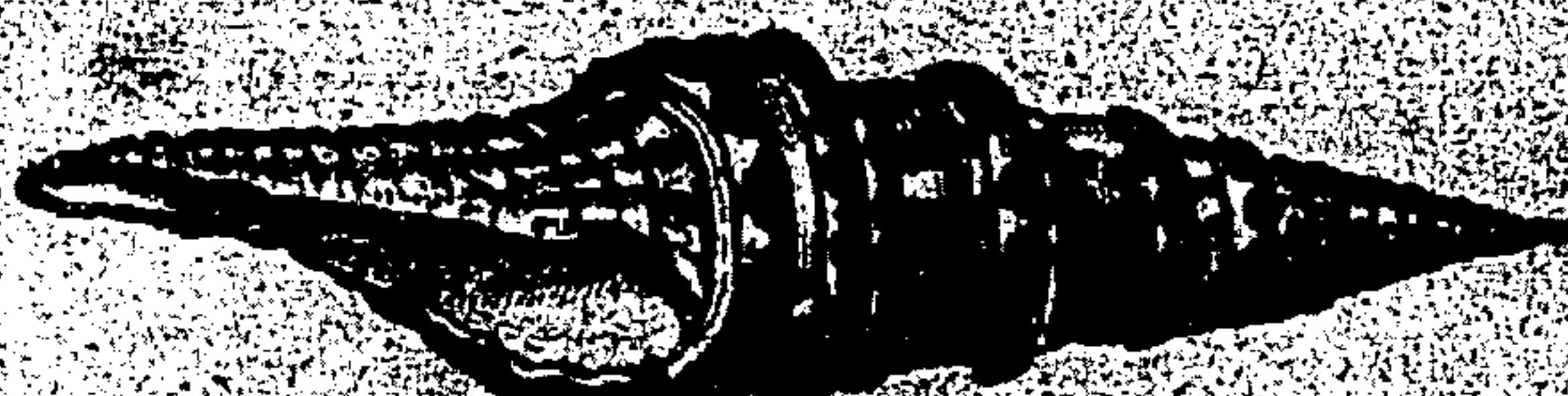
## THE TULIP SHELL



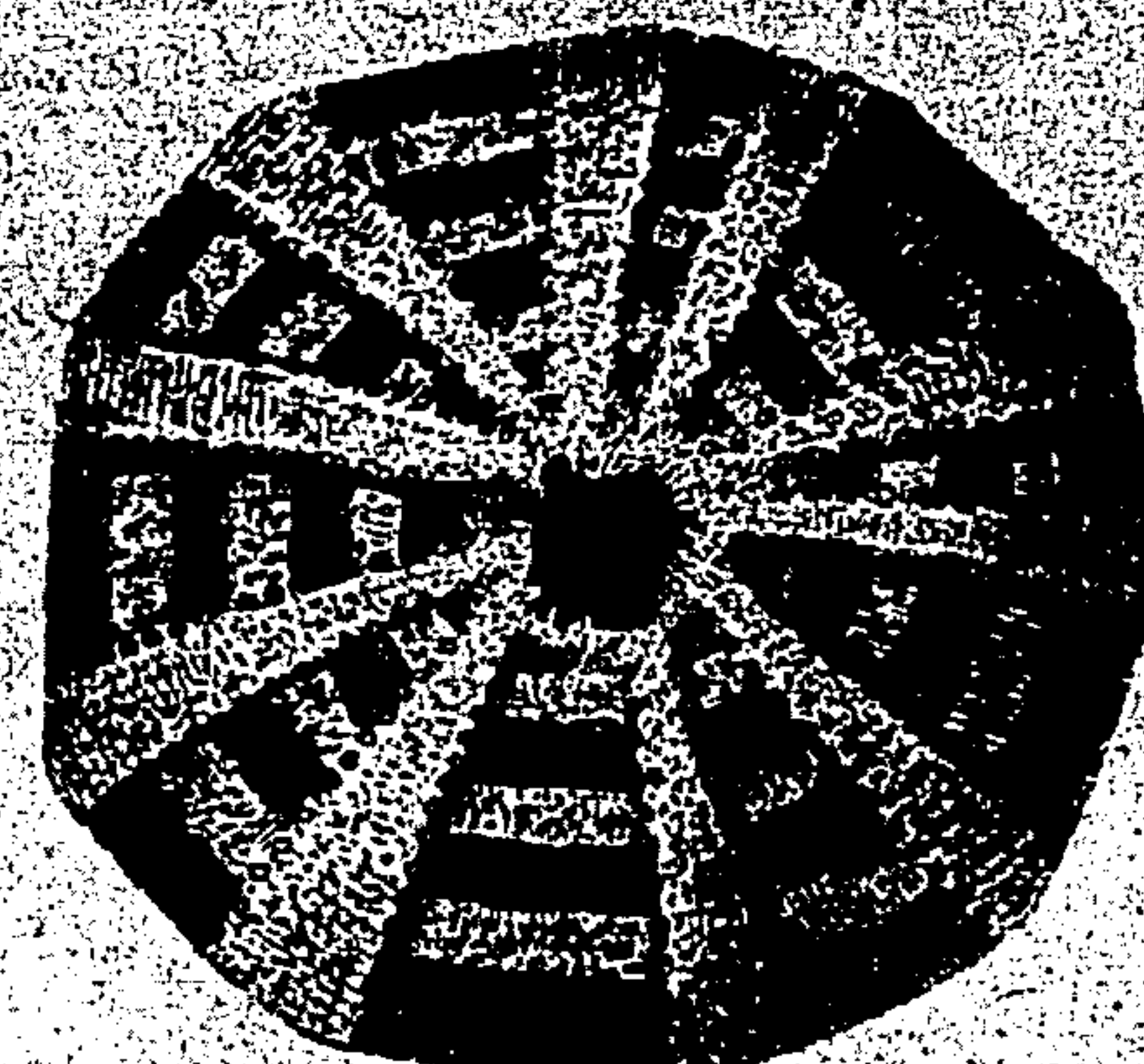
# THE PORPHYRY SHELL



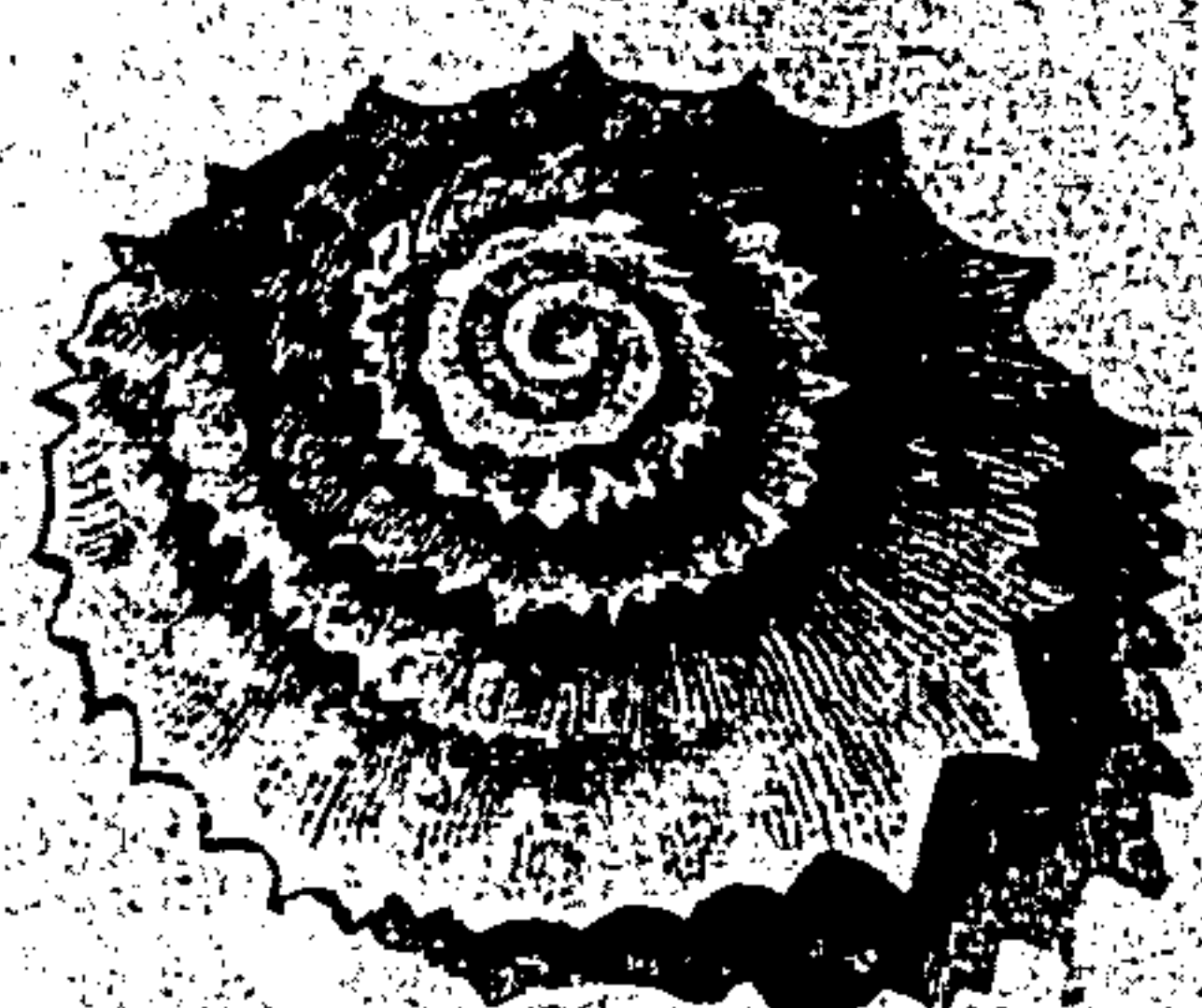
## THE HIGHBACK'D SEA EGG



## THE TOWER OF BABEL SHELL



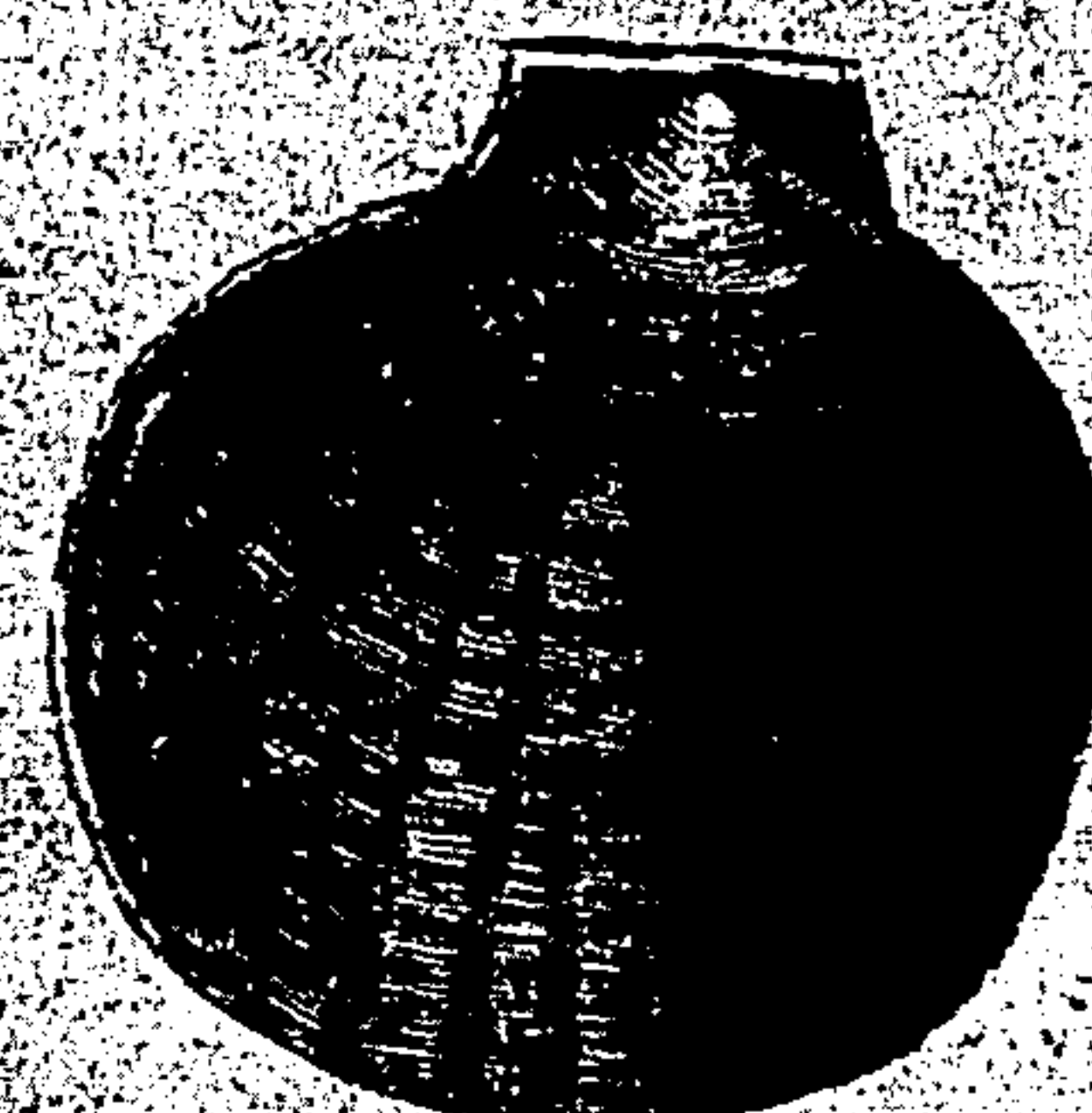
**THE GLOBE SEA EGG WITH  
VARIOLATED PAPILLÆ**



## THE ROUGH TROCHUS



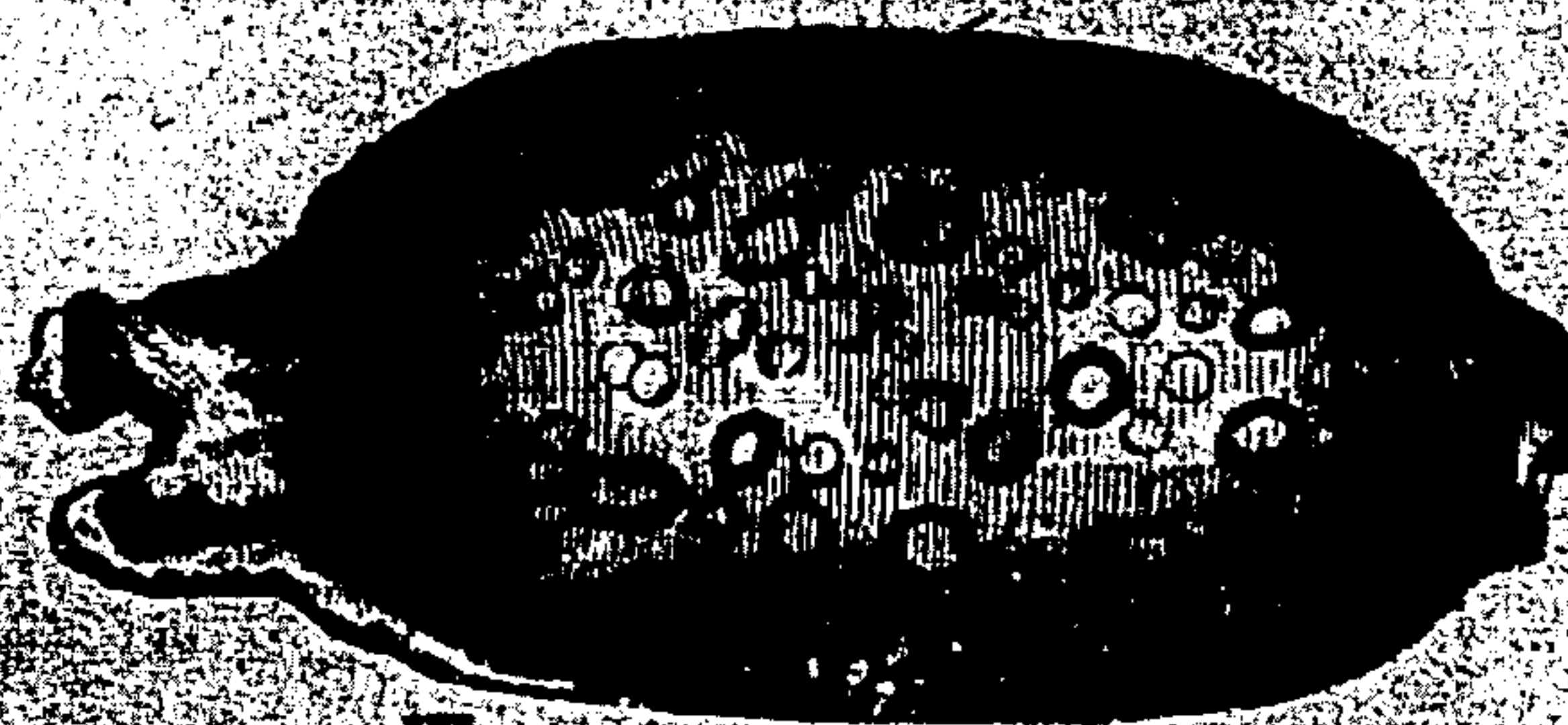
# THE GREAT PRICKLY OISTER



# THE THIN SCALLOP



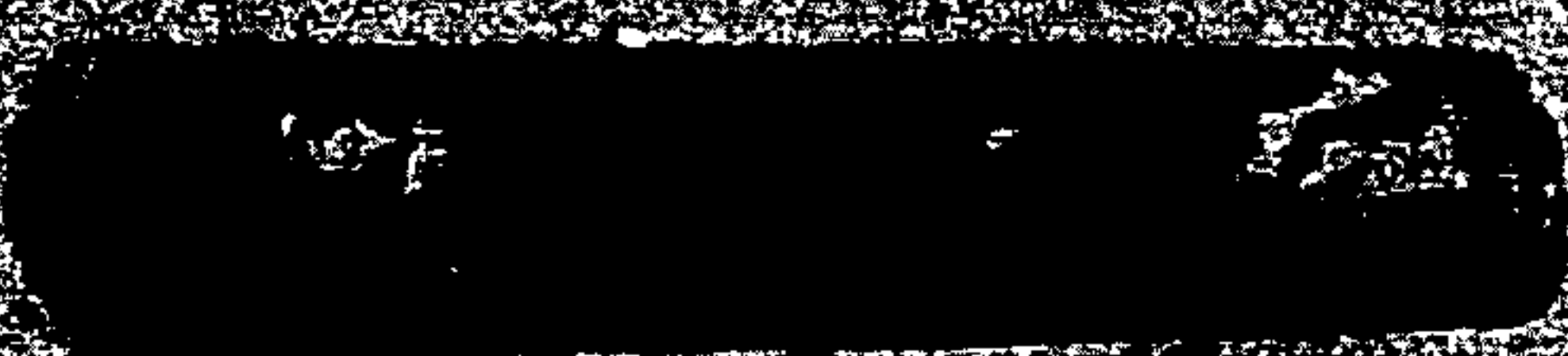
# THE CONIC MUSCLE



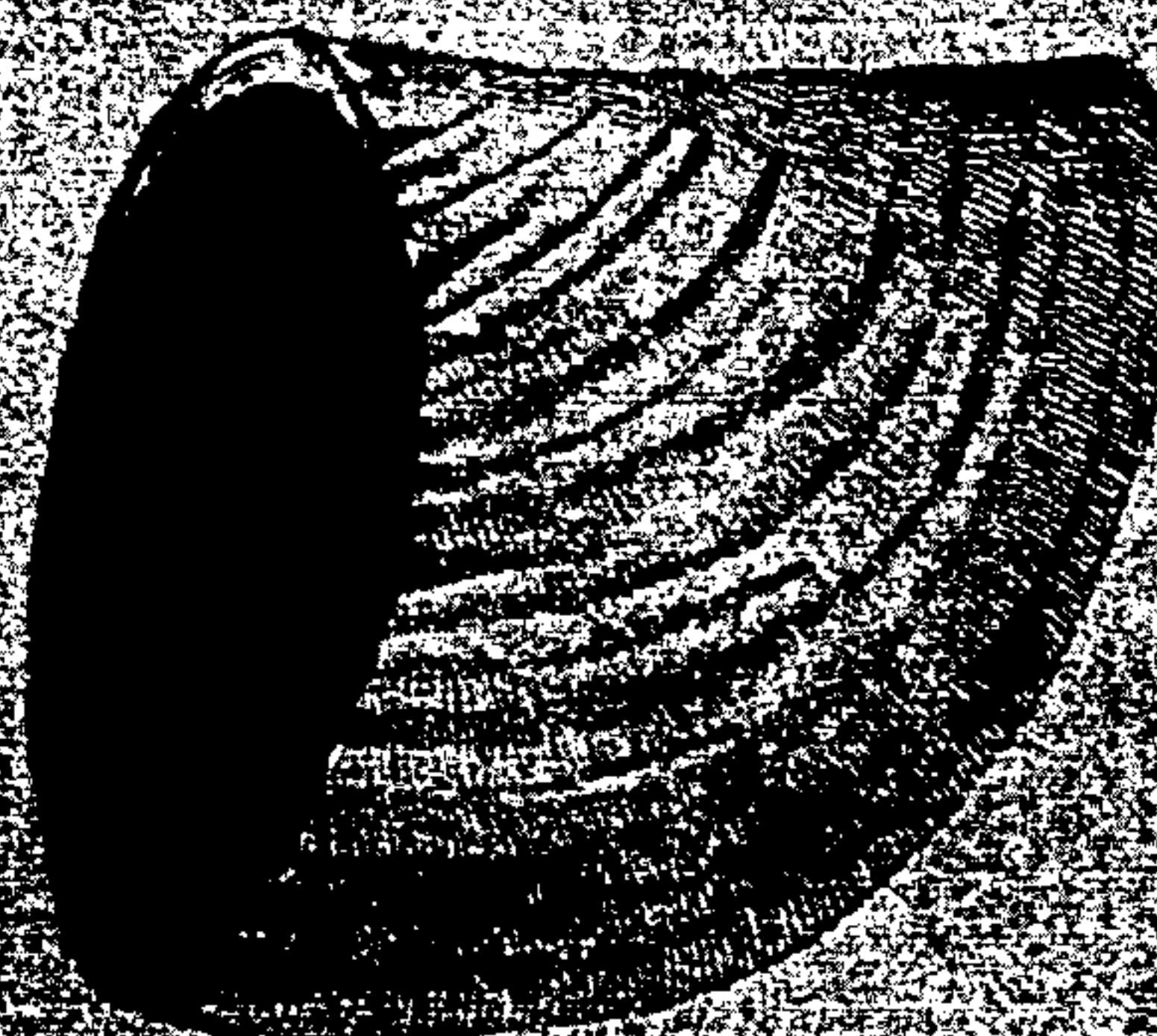
# THE ARGUS SHELL



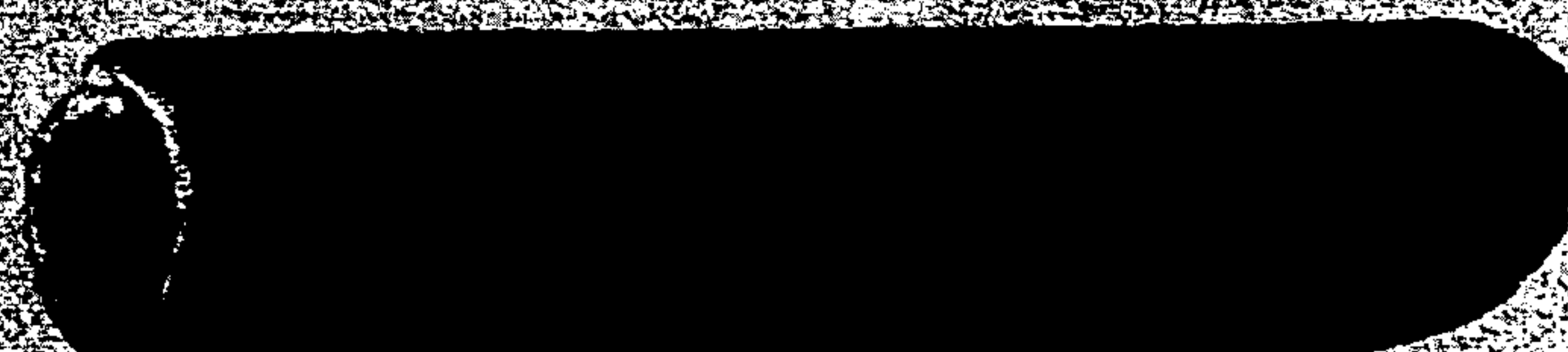
# THE CAROLINA MUSCLE



100-443887-100

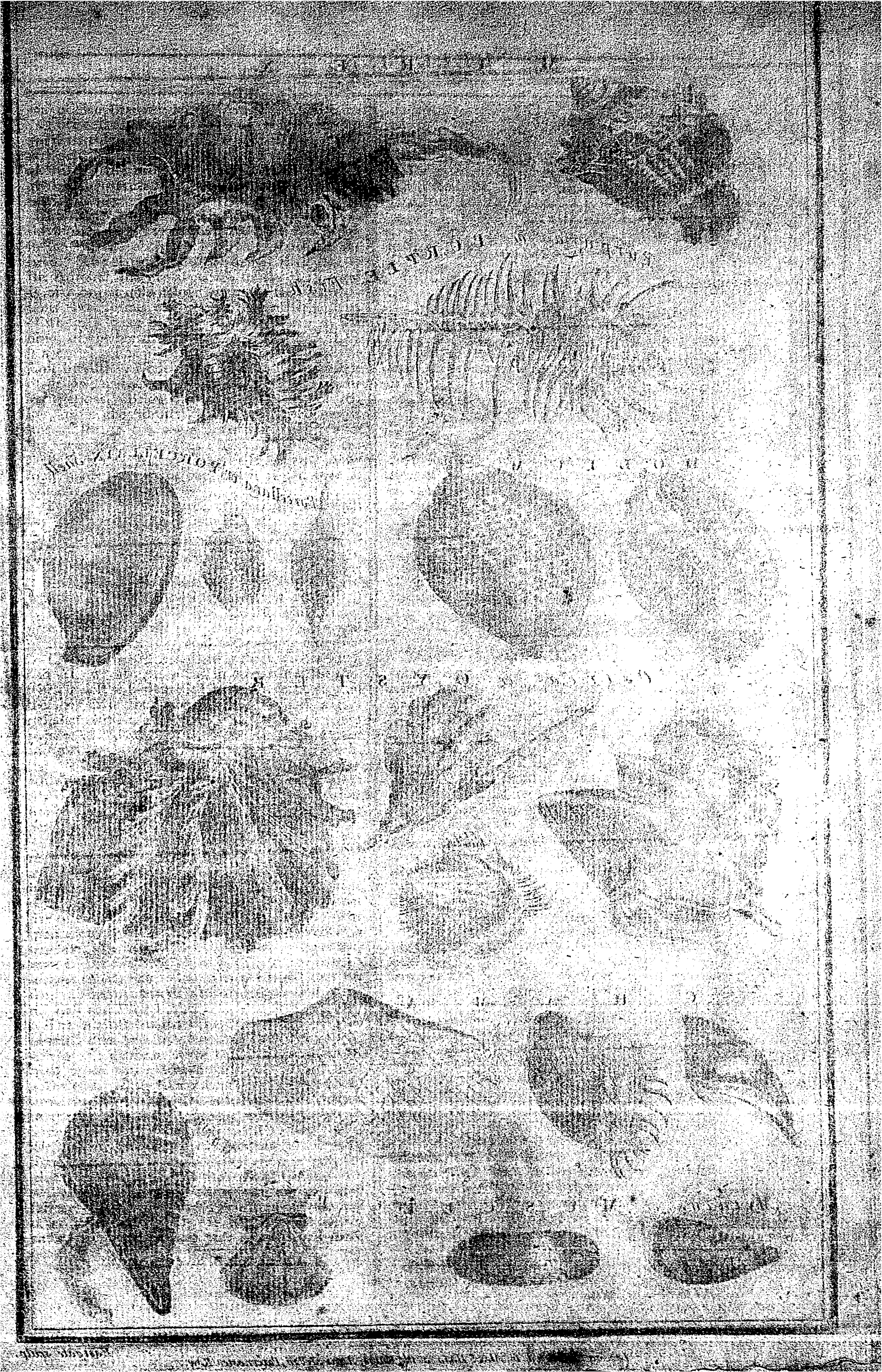


# THE SMOOTH EDGED TAPERED CHAMA



## THE THICK RAZOR SHELL



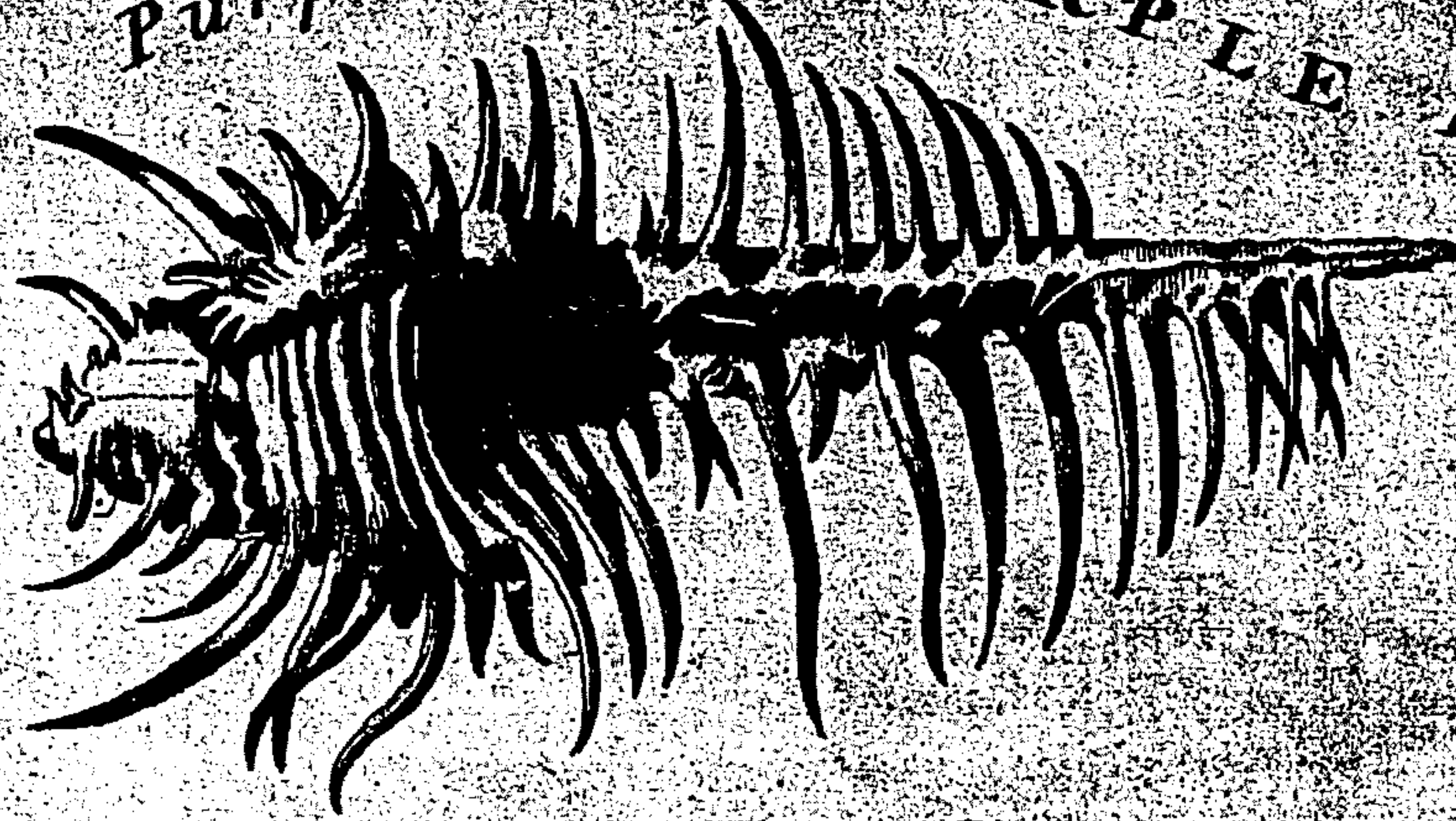




M U R E X

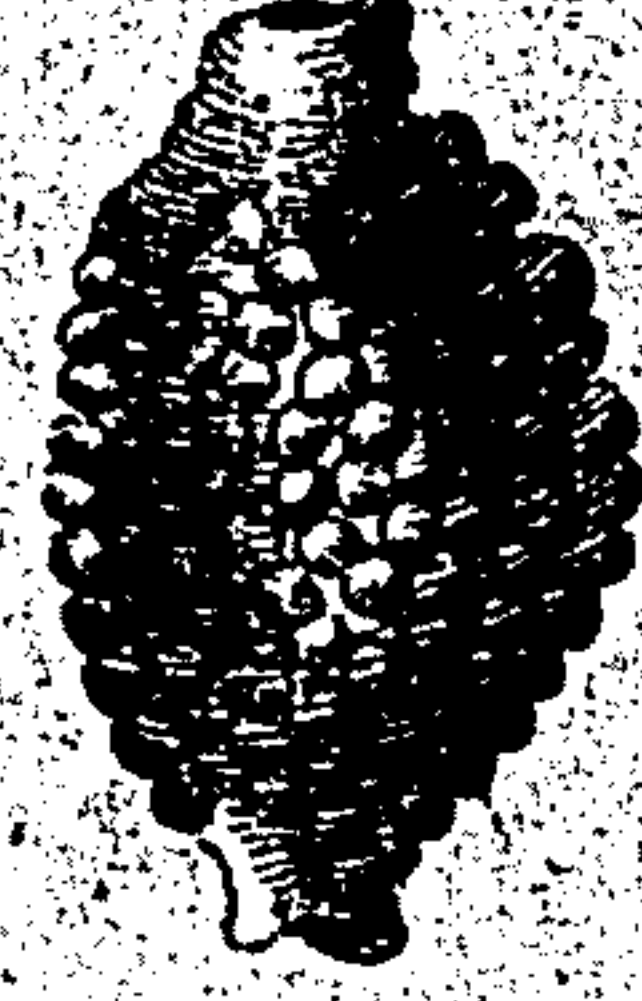
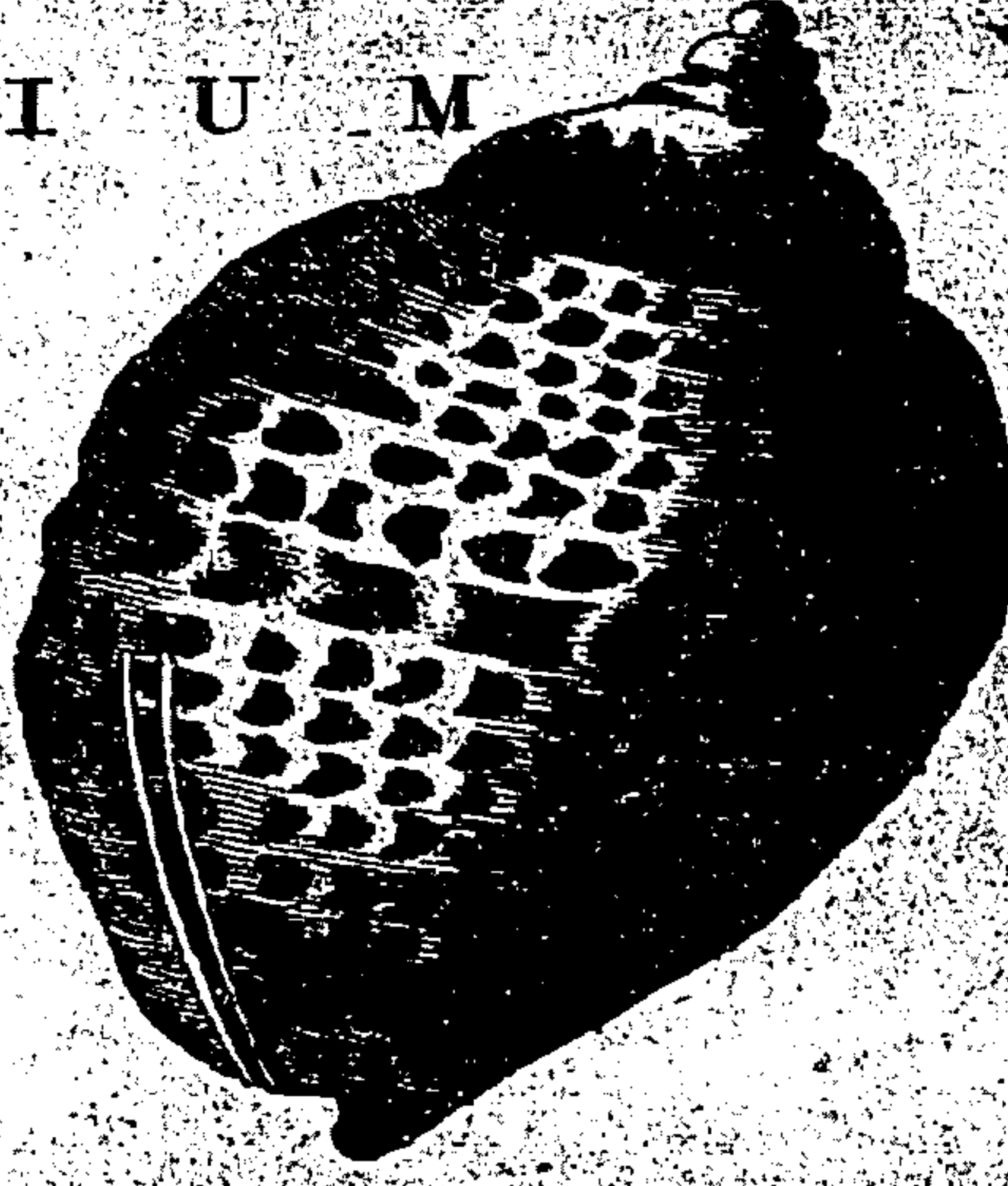


*Purpura* or PURPLE Fish



D O L I U M

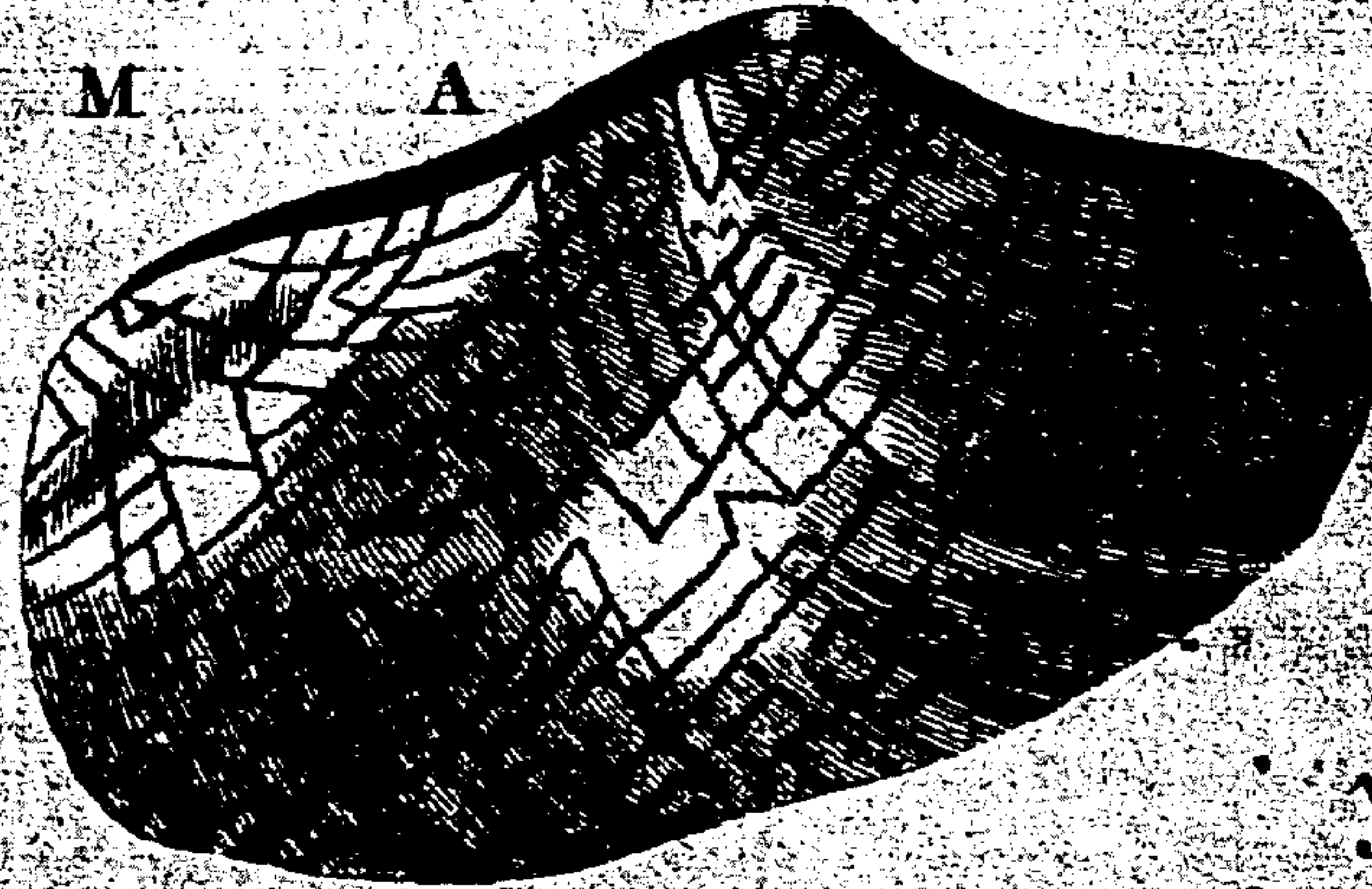
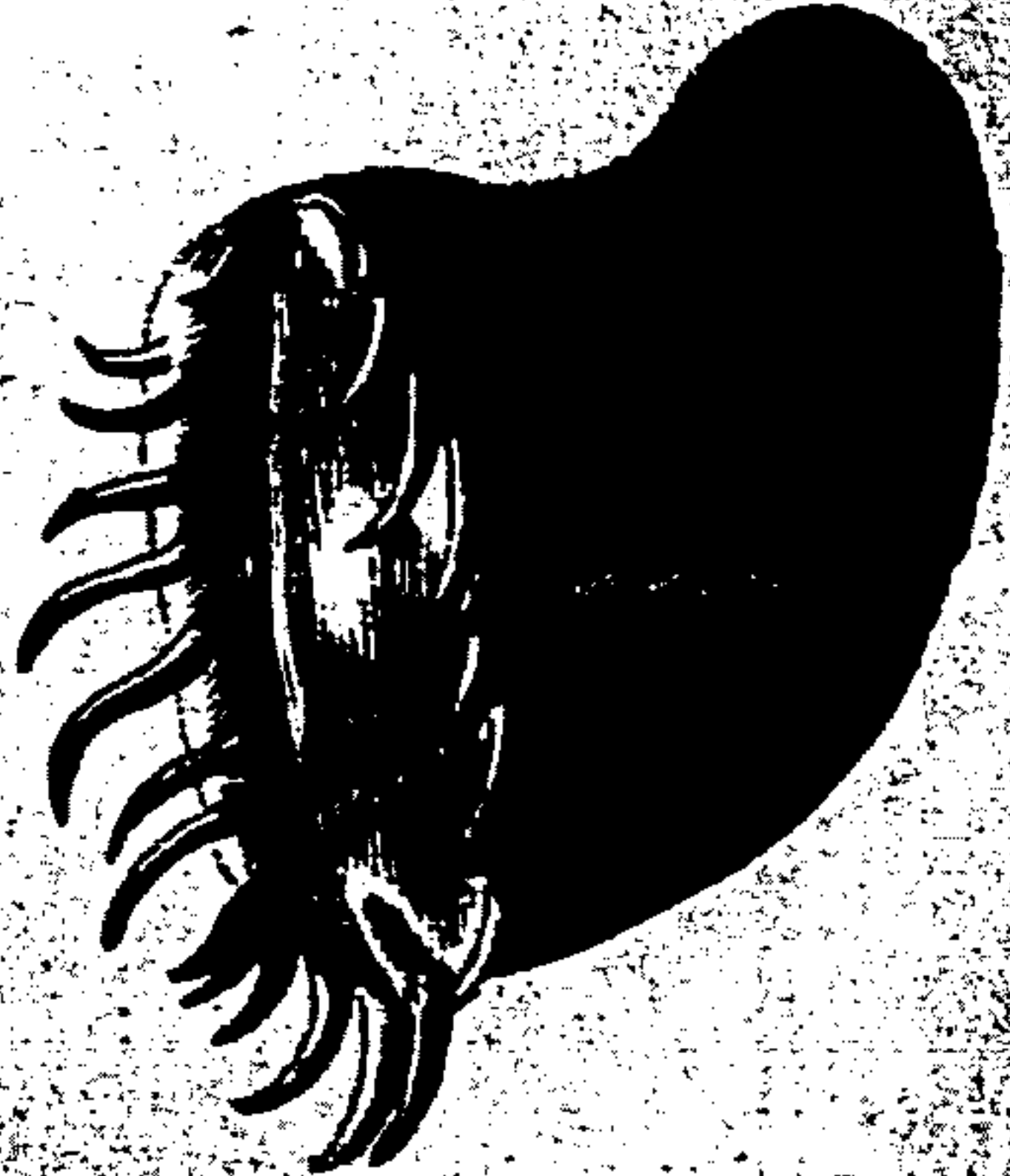
*Porcellana* or PORCELLAIN Shell



*Ostrea* or O Y S T E R

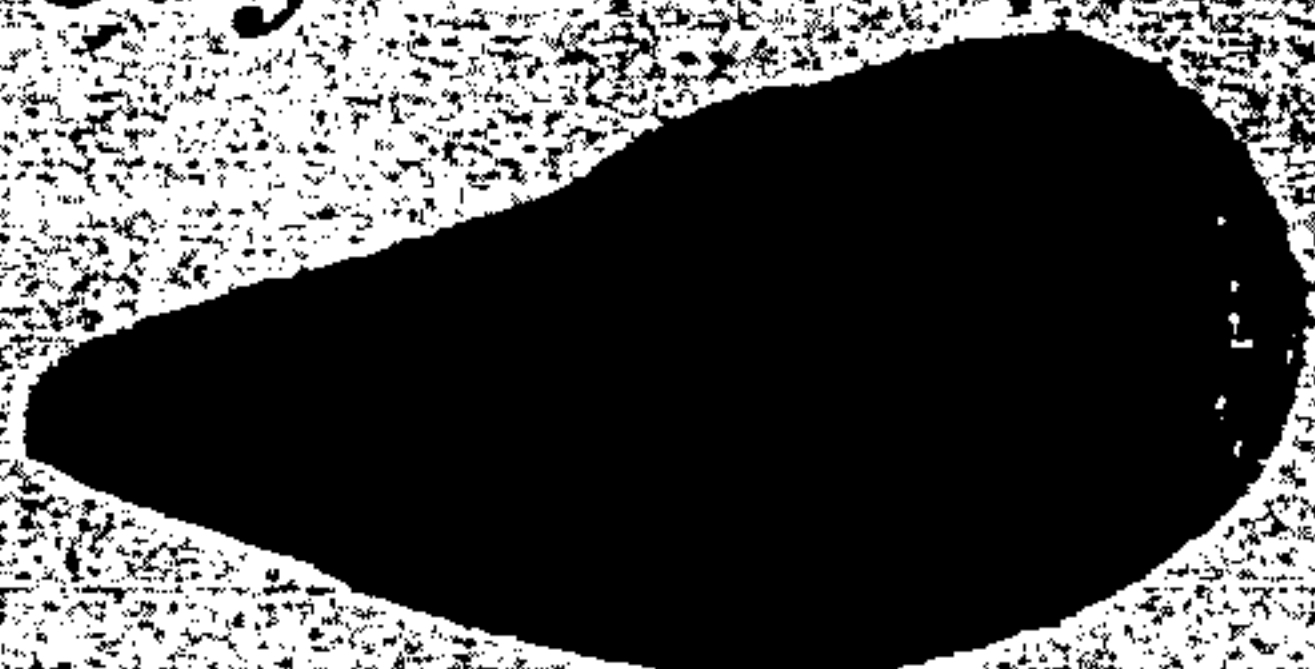


C H A M A



*Mytilus* or M U S C L E

P I N N A Marina





makes its appearance in the form of a broad belt; and in the centre there is a narrow pointed line of the same colour with the other variegations, which is the characteristic of this shell. From the verge of this, to the extremity of the shell, the yellow gold colour prevails again. It is brought from the East Indies.

The Vice-Admiral Shell is nearly as beautiful as the former, and is somewhat more than two inches in length, and about an inch in diameter at the head. The clavicle is a little longer than that of the Admiral, and has about ten turns; the ground is of a bright gold colour, with the same variegations as the former, only they have a greater mixture of white. There is a line of gold colour at the head, of the breadth of a straw, below which there is a circular line of the variegations, much of the same breadth. Under this there is a narrower line of yellow, and under that a very broad belt of the variegations. Below this there is another of yellow, as in the Admiral, but without the pointed line. Next to this there is another broad belt of the variegations, and then comes the point of the shell, which is yellow. The False Admiral is by some taken for the true one, but it is not near so valuable.

The Tiger Shell is scarce, and brought only from the East Indies. Its ground is of a dusky red, sprinkled all over with irregular spots, a little whitish; some of these are oblong, others angular, and indented.

The Yellow Tiger Shell is beautifully variegated with white irregular spots of the size of a pea.

The White Voluta is of a faintish white, variegated with dusky red spots, that are very large, and of irregular figures disposed without any order.

The Crown Imperial Shell is three inches long, and near an inch and a half in diameter at the top. The clavicle is so depressed, that in a front view of the shell it is not to be seen. The head is surrounded with a very beautiful row of tubercles pointed at the ends, and the ground colour is pale, with two broad beautiful belts, running round it, the one near the head, and the other towards the other extremity. They are of a fine yellow, prettily variegated with black and white. It is brought from the East Indies, though few of them are quite perfect.

The Hebrew Letter Shell is smaller than the rest of this kind; for it is rarely above an inch and a quarter in length, and three quarters of an inch in diameter at the top. The body is in the shape of a cone, and the clavicle pretty long, with about five turns, but it is blunt at the extremity. The ground colour is of a pearly white, variegated with large irregular black marks, disposed in about four rows on the body, and there is a single row to each turn of the clavicle. Some have fancied they resemble Hebrew letters. It is brought both from the East and West Indies.

The Whitish Voluta, variegated with brown and purplish blue spots, is more than four inches long, and two in diameter at the head, from whence the body tapers very gradually, and is large and blunt at the end. The clavicle consists of seven or eight turns, and is blunt at the extremity; the ground of the shell is white, variegated with spots of different sizes running in circles round it; these circles are from twenty to thirty in number on the shell, some of which are brown, and others of a purplish blue. It is brought from the coast of Guinea.

The Half-Crowned Voluta, with an undulated surface, is more like the Crown Imperial than any other shell of this kind. It is about two inches and a half in length, and near an inch and three quarters at the head. The edge of this is deeply

indented, so as to form a kind of crown. The colour is white, and the variegations of a faint brown. It is brought from the coast of Africa. To which may be added, the Slender Voluta.

The Butterfly Shell has three very beautiful belts round the body, and one narrower near the head, consisting of large spots of a deeper and paler brown, with some white: they resemble the spots, in the form of eyes, on the wings of some butterflies.

## OF LIMPETS.

Limpets are simple shells of a conical, or gibbous shape, with a very wide opening at the bottom; of these are the—Streaked—Starry—Oval Smooth—The Great Oblong—and many other sorts, for which we refer our readers to the plates of Shell-Fish and Shells.

## SEA-EAR-SHELLS.

The Haliotis or Ear-Shell is a simple one, of a depressed shape, with a large mouth, having somewhat of a spiral form at top: among this kind are reckoned the—Great Ear—The Long Ear—and the Streaked, or Wrinkled Ear-Shell.

## DENTALIA, or TOOTH SHELLS.

Of these are distinguished the Streaked—The Ringed—The Dog-Tooth—Conical—Crooked Streaked, and Ringed; and the Great Sea-Pipe.

## OF CYLINDRIC SHELLS.

The Brocade Shell is large and beautiful; the colour being as white as silver, variegated with a bright brown, in fine irregular lines, clouds, and spaces.

The Tulip Cylinder. The colour of this shell is white, variegated with clouds and spots of blue and brown. It is very scarce, and is brought from the East-Indies; but seldom in perfection.

The Porphyry Shell is about two inches and a half long, and an inch and quarter in diameter. The shape is nearly like that of a cylinder, with a short blunt clavicle. The colour is of a pale white, with a reddish cast, clouded with a deeper red, approaching to purple, which takes up much the greater surface. This colour appears in most places in irregular longitudinal and dentated lines. It is brought from South America.

The Slender Whitish Cylinder Shell, variegated with brown, is three inches and a half long, and near an inch and quarter in diameter. It is shaped nearly like a cylinder, only it is somewhat smaller towards the point than elsewhere. The clavicle has four or five turns, and the body of the shell is cloven at the other extremity, by the continuation of the mouth. The colour is white, with a broad belt near each end, variegated in such a manner that some have imagined there are letters thereon. It is brought from the East Indies and South America.

The Slender ditto, variegated with brown and white, is three inches long, and about an inch and quarter in diameter. Its shape is nearly like that of a cylinder, only it is a very little smaller at both ends than in the middle. The clavicle is blunt, though it has four or five turns, and the whole shell is variegated with a bright white, and a pale tawny brown. They are disposed in denticulated lines, and the surface appears to be finely polished, it being very bright. It is brought from South America.



## OF DOLIA, or PIPE SHELLS.

Pipe Shells are so called, from being imagined by some to be like the pipes or calks made to hold wine. However their shapes differ so much that it may be doubted whether this appellation is proper. In this class among others are placed the—Oval Pipe Shell—The Partridge Shell—The Harp Shell—And the Ethiopian Crown. The shape of the last is oblong, and somewhat oval, being smaller at each end than in the middle. The mouth is long and wide, and cleaves the extremity of the shell a little way. The clavicle is short and blunt at the end, and has four turns; that next the body, as well as the upper edge of the body, are deeply dentated, or as some say crowned, and the teeth are formed into regular even conical points. The surface is pretty smooth, only there are impressions of longitudinal lines; and the colour is of a pale brownish yellow. It is brought from Africa and the East Indies. There are some other sorts of this shell, which, for the sake of brevity, we shall omit.

## OF PORCELAIN SHELLS.

The porcelain is a simple shell, consisting of one piece gibbous on the back; the mouth is long, narrow, and dentated on each side.

The White Porcelain Shell, yellow within and beaked at each end, is of an oblong shape and very gibbous. The length, including the beaks, is about three inches, and its diameter in the middle nearly two. It is white on the outside, and yellow within; and the mouth is large, having a sort of a snout or beak at each end. It is brought from Africa and the East Indies.

The Argus Shell is about three inches long, two in diameter, and somewhat less in height, though it is gibbous like the former. The mouth is wide, and the lips are continued at each extremity in the form of a broad short beak each way. The general colour is yellowish, only there are three brown bands of a considerable breadth running over it; the whole surface is adorned with a multitude of round spots like eyes, from whence it has its name. It is brought from Africa and the East Indies.

The Map Shell is about two inches and a half long, and nearly as much in diameter, with a gibbous back. At the head there is a short clavicle, placed a little above the extremity of the mouth, consisting of about four imperfect turns. To these may be added, the—Bluish Banded Porcelain—The Oval Porcelain—The White Porcelain—The Small Pox, and the Beetle.

## OF BIVALVED SHELLS.

Of these there are six kinds, namely, Oysters, Bastard Cockles, Muscles, Heart Shells, among which Common Cockles are included, Scollops, and Razor Shells.

The Hammer Oyster has one of the most extraordinary shells in the world, it being in shape like a hammer, or rather like a pick-ax, with a very short handle and a long head. The body of the shell, which is taken for the handle, is about four inches long, and three quarters of an inch broad; but the head is five or six inches long, and except where it joins to the body, is little more than half an inch broad. It is of an irregular form, uneven at the edges, and terminates in a narrow blunt point at each end. The hinge or joint is at the lower end of the body; and the shells open all the way from each end to this part, and yet they shut very close. The edges of the body and head have often

great irregularities and protuberances on the surface, being deeply furrowed in all directions.

Under this class are included the Pearl Oyster—The Great Prickly—The Conical—The Hedge—Hug—and others, for an account of which see page 210 of the Natural History. Of Cockles are reckoned the Bastard—The Truncated Bastard—The Arabian Shell—The Venus, or Concha Veneris, and the—Oriental Concha Veneris.

## OF MUSCLES.

These are composed of two valves or shells, of a longish shape, that shut all the way, and are both convex. Our sea and river Muscles are too well known to need any description.

The Carolina Muscle is four inches long, and an inch and a half broad.

The Ader is a very curious shell, of a fine sky-blue colour, with yellow rays one over another towards the bottom.

The Anpan has a bivalved shell, and is one of the largest that is met with at Senegal.

The Pinna Marina is of an olive brown colour on the outside; but within it is partly of a pearl colour, and partly reddish.

The Prickly Pinna is furnished with a sort of scales, many of which terminate in prickly points.

To which we may add Heart-shells and Cockles, as the—Thin White Heart—The deeply furrowed and Spinous Heart.

Scollop Shells, as the ribbed and variegated—The Red Ribbed and Furrowed—The Ducal Mantle—and the Irish Scollop.

Finger Shell Fish, as the Thick Red Finger—The crooked Finger—The slender, straight Brown and White—and the Violet Purple Finger Shell.

Acorn Shell Fish, as the Great Furrowed—The Bell fashioned—and the Greyish-white, Furrowed, Slender Acorn Shell.

Thumb-footed Shell Fish, as the Blueish Grey—The Reddish—and the White.

File Shell Fish, or the Pholades, as the longish White, Chequered and rough—The White and West Indian Pholas.

## OF FRESH WATER SHELL FISH.

The Oval Limpet, with a crooked snout, is very thin, oval and depressed, except in the middle, where it rises into a beak. It is no bigger than a man's finger nail, and is found sticking to stones in the brooks of Northamptonshire.

The roundish Target Limpet is smaller than the former; and, instead of a beak, has a sort of button at the top. It is very thin and delicate, and has a pretty smooth surface, of an olive brown colour. It is found in some of the rivers of Leicestershire.

The Oval Limpet, with a hole at the top, is a quarter of an inch in diameter, and an eighth in height. The shell is very thin, rounded at both ends, and of a dusky brown colour. The hole is small and oblong, and seems to be formed of two round holes broken into each other. This is common near London.

The Spiral Snail Shell, with a clavicle a little elevated, and a round mouth, is three quarters of an inch in diameter, and the shell is firm, solid, and smooth at the surface. It consists of about four turns, and the clavicle at the center is raised above the rest of the surface. The colour is a greyish white, and the large turn has a streak of black running along it, but loses itself before it reaches the next turn. It is found in the lakes in the north of England.



## T E N T H

of the Oak



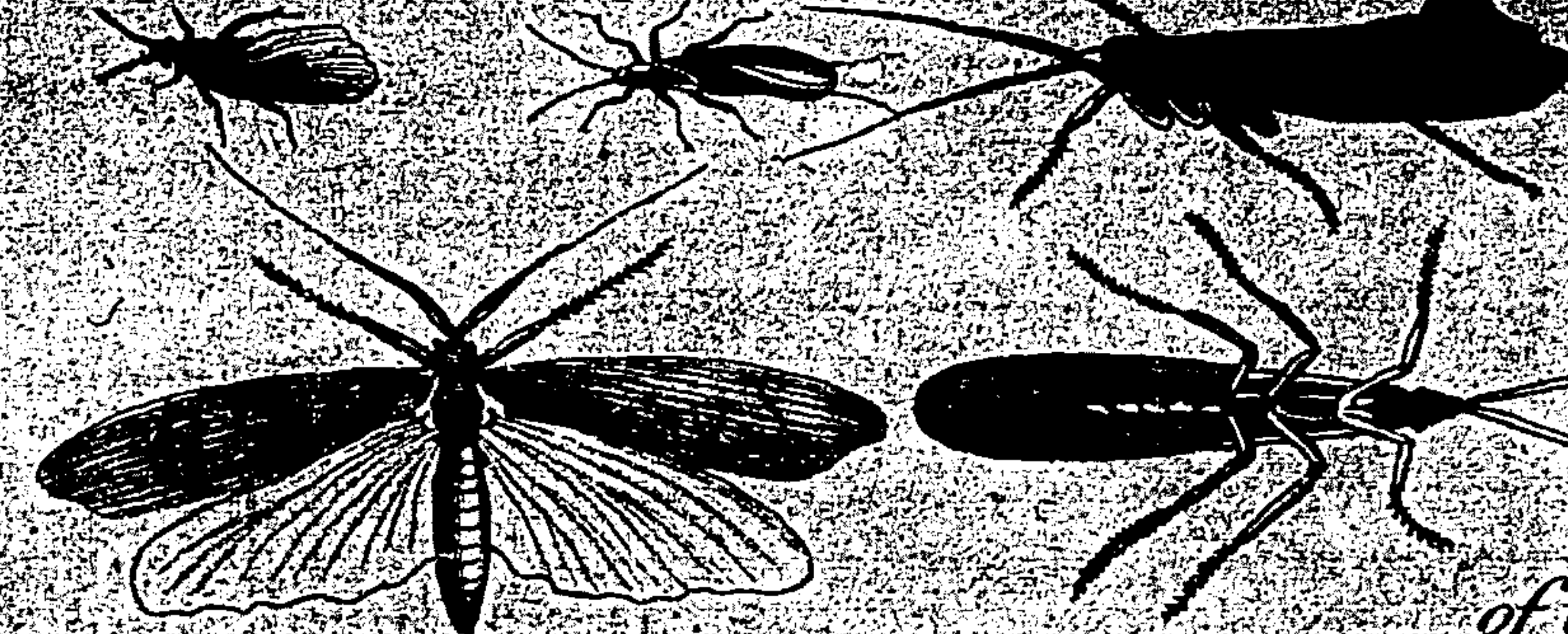
of the Hornbeam



Cadeworms & Cases



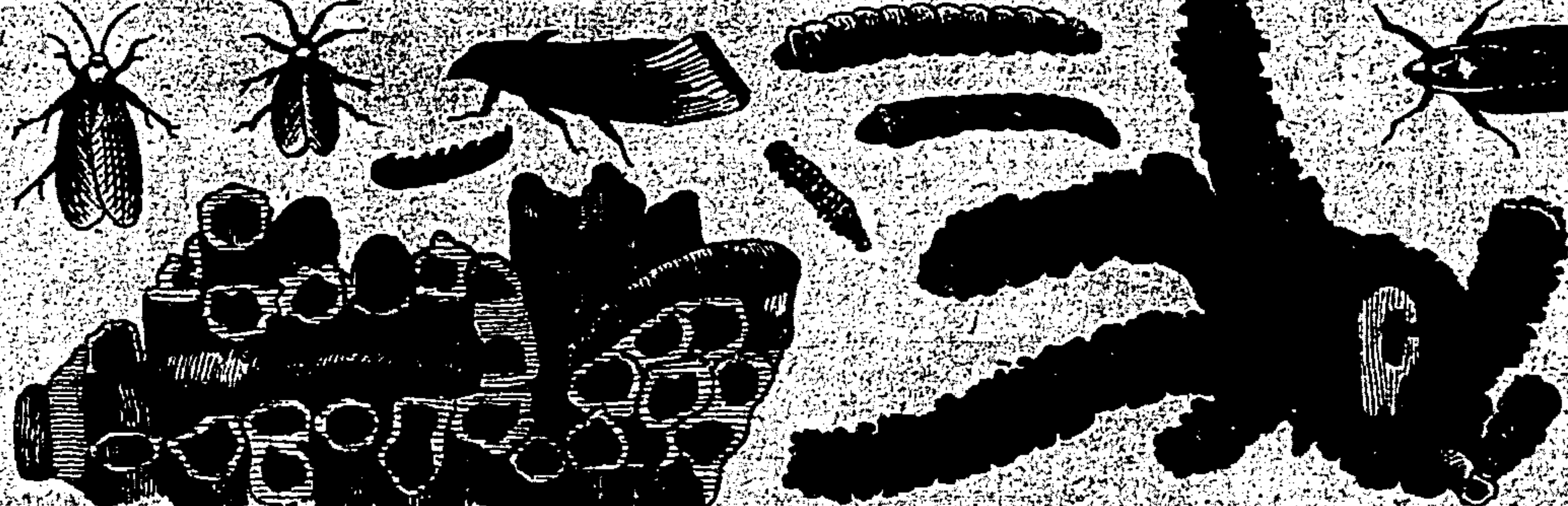
Papilionaceous Flies of Cadeworms



of the Lily & its Beetle



of the Honey comb with their Pipes or Cases



of the Artichoke & its Aurelia

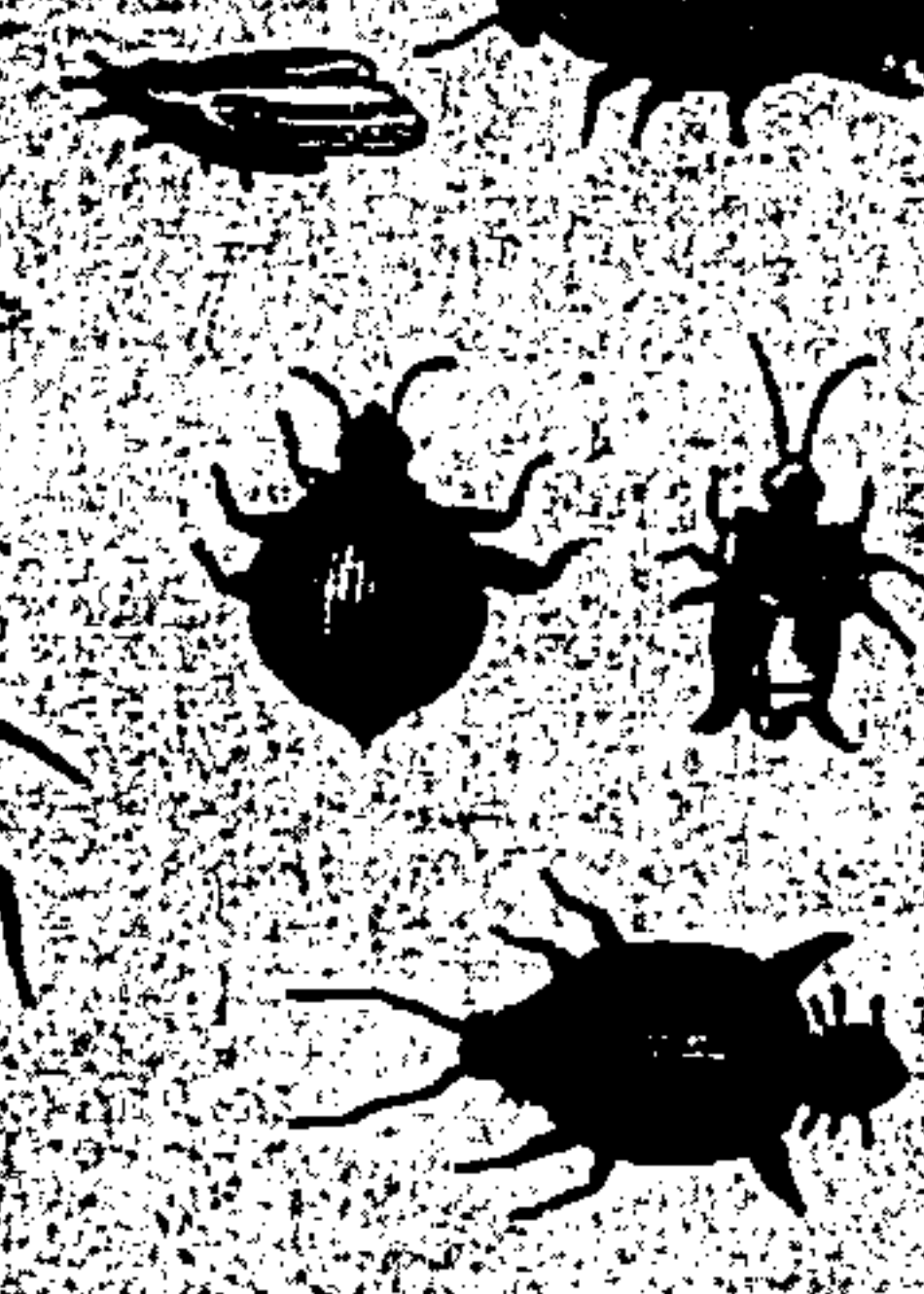


## P U C E R O N S

of the Rose



of the Elder



of the Peach

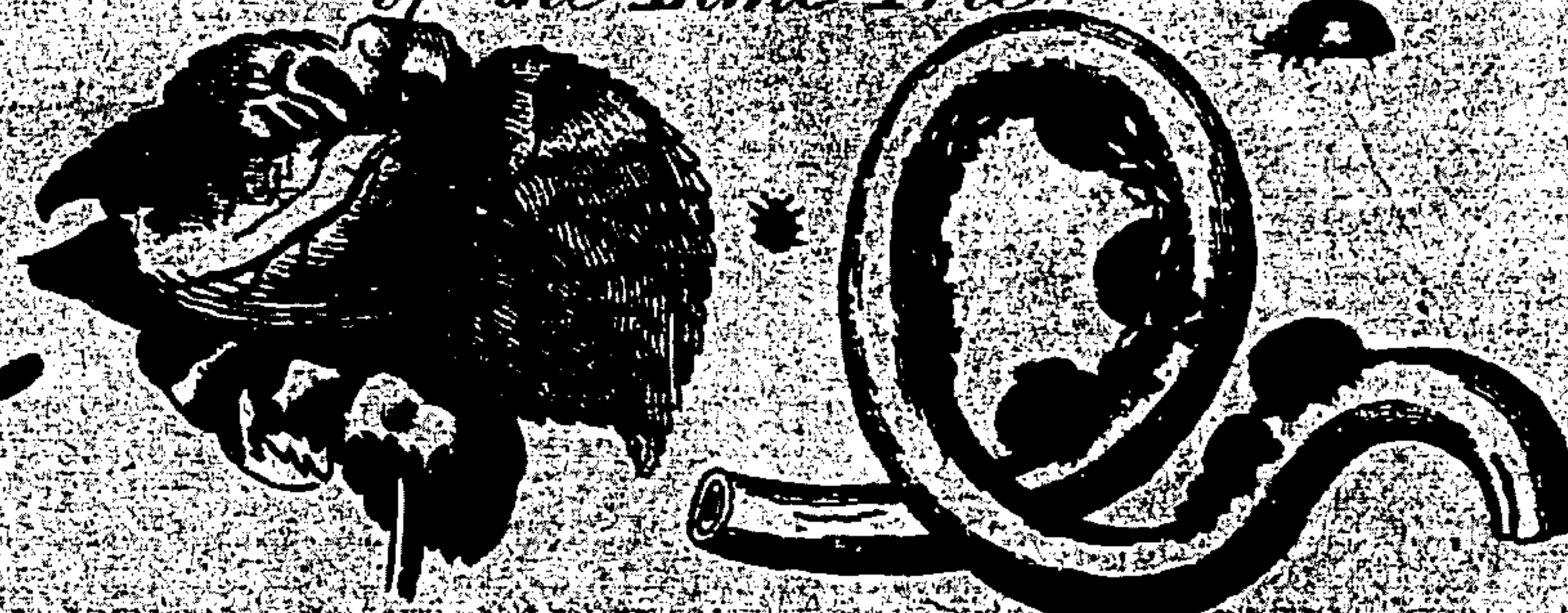


of the Rose (naked)



Nat size

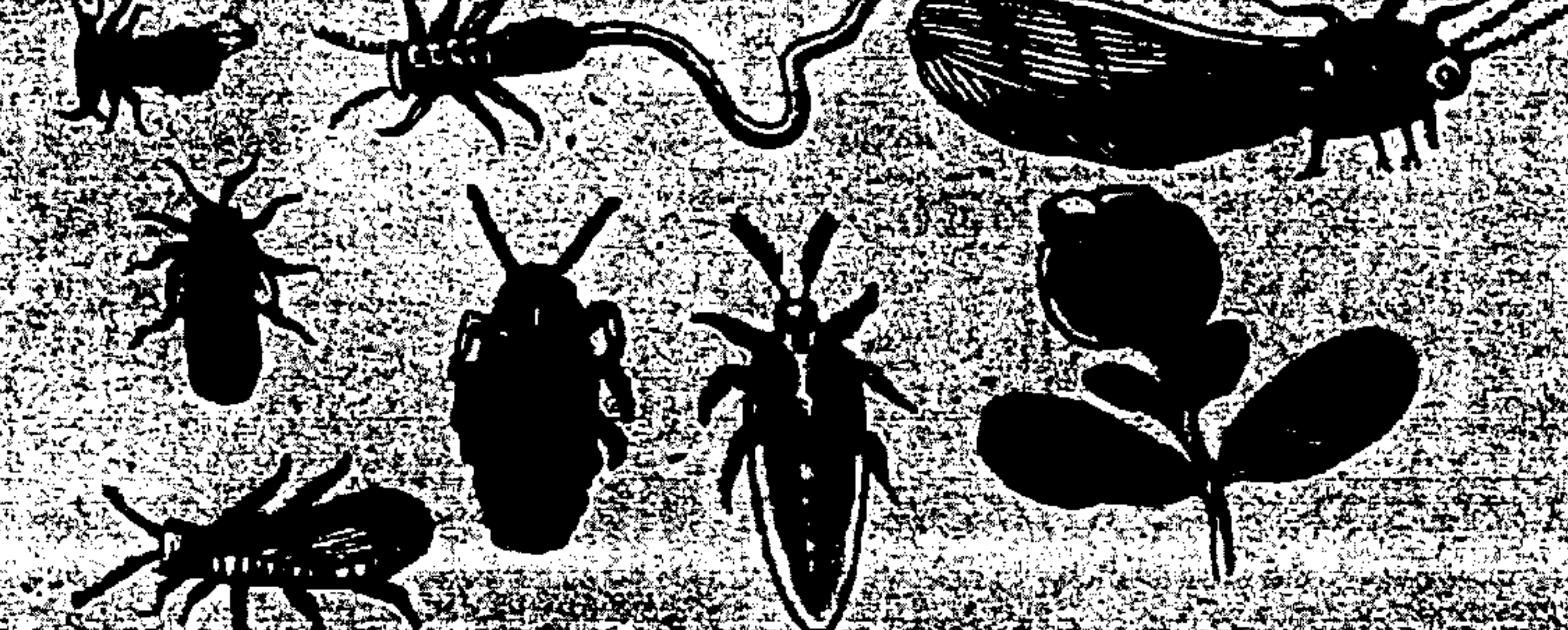
of the Lime Tree



of the Beech



Bastard Pucerons & Flies



Puceron-eaters & Flies

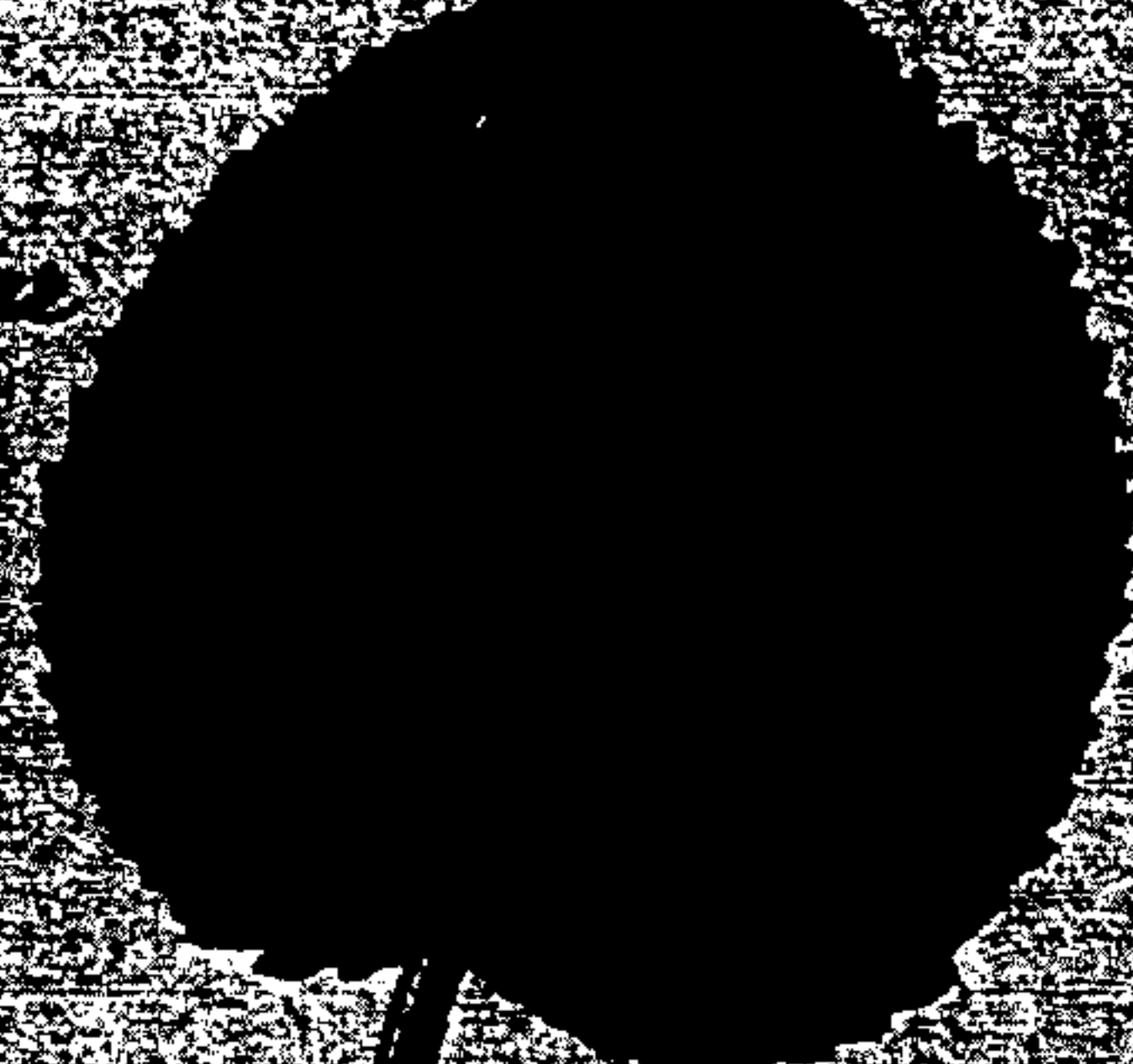


of the Fig Tree & Bug



## Leaf GALLS & Insects

of the Lime Tree



of the Carduus Hemorrhoidalis



Nat Size

Magnified

of the Oak

of the Chamadrys



Magnified

Nat Size